July 14, 1958

Aviation Week

Including Space Technology

cents

A McGraw-Hill Publication

Mach 3 Aircraft Designs Pushed

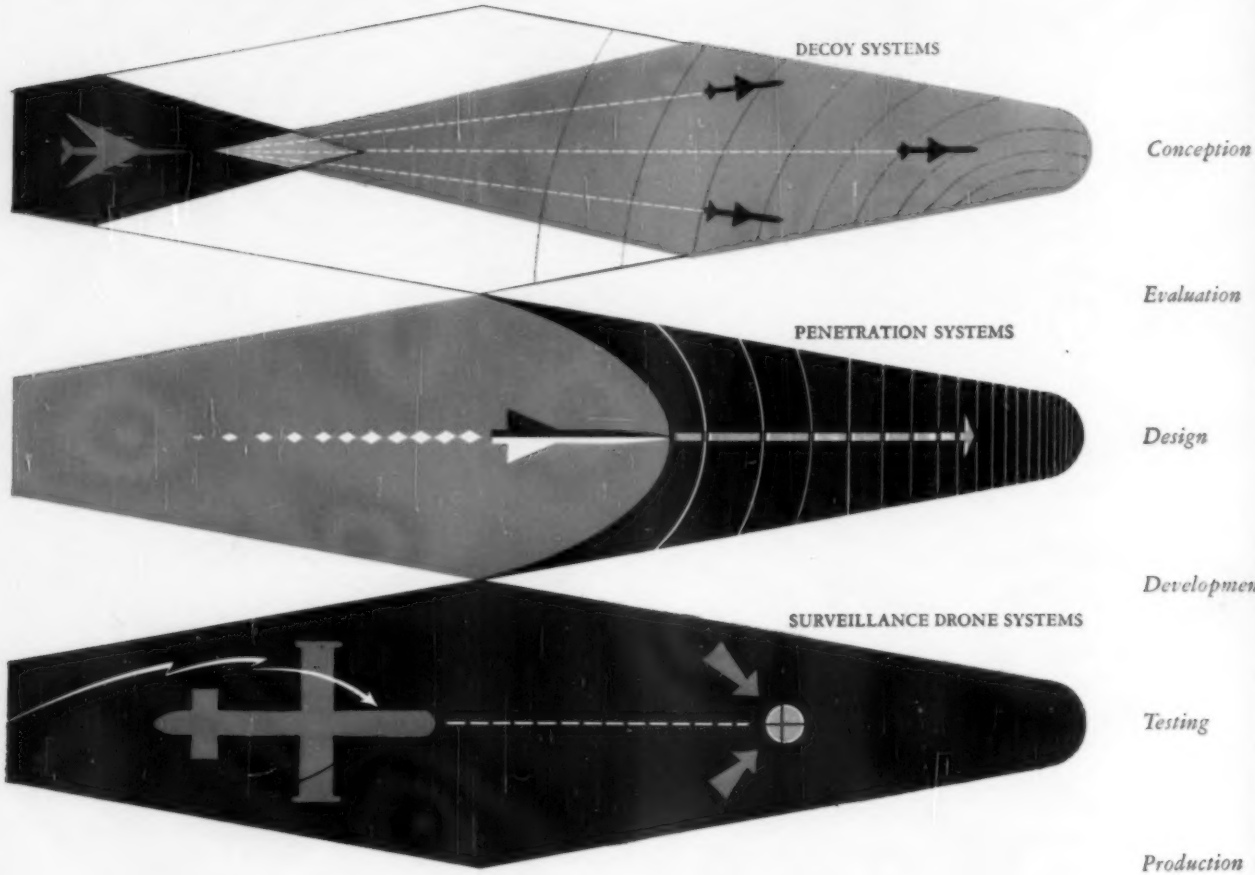
—

Area Rule Aids Jet Transports

Vertol 107 Helicopter

DRONE and SMALL MISSILE SYSTEMS

Research and Development at Rheem Aircraft Division has a record of achievement in the field of drone and small missile systems. The capability for complete "program management" is manifested in the list of current and completed projects and the areas of responsibility covered.



Rheem Aircraft is a division of world-wide Rheem Manufacturing Company which operates 17 plants in the United States...and with its associated and licensed companies operates 18 plants in 12 countries abroad. These extensive facilities coupled with Rheem's years of aircraft production experience provide the capability for the quantity production of drone and missile systems.

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Rheem

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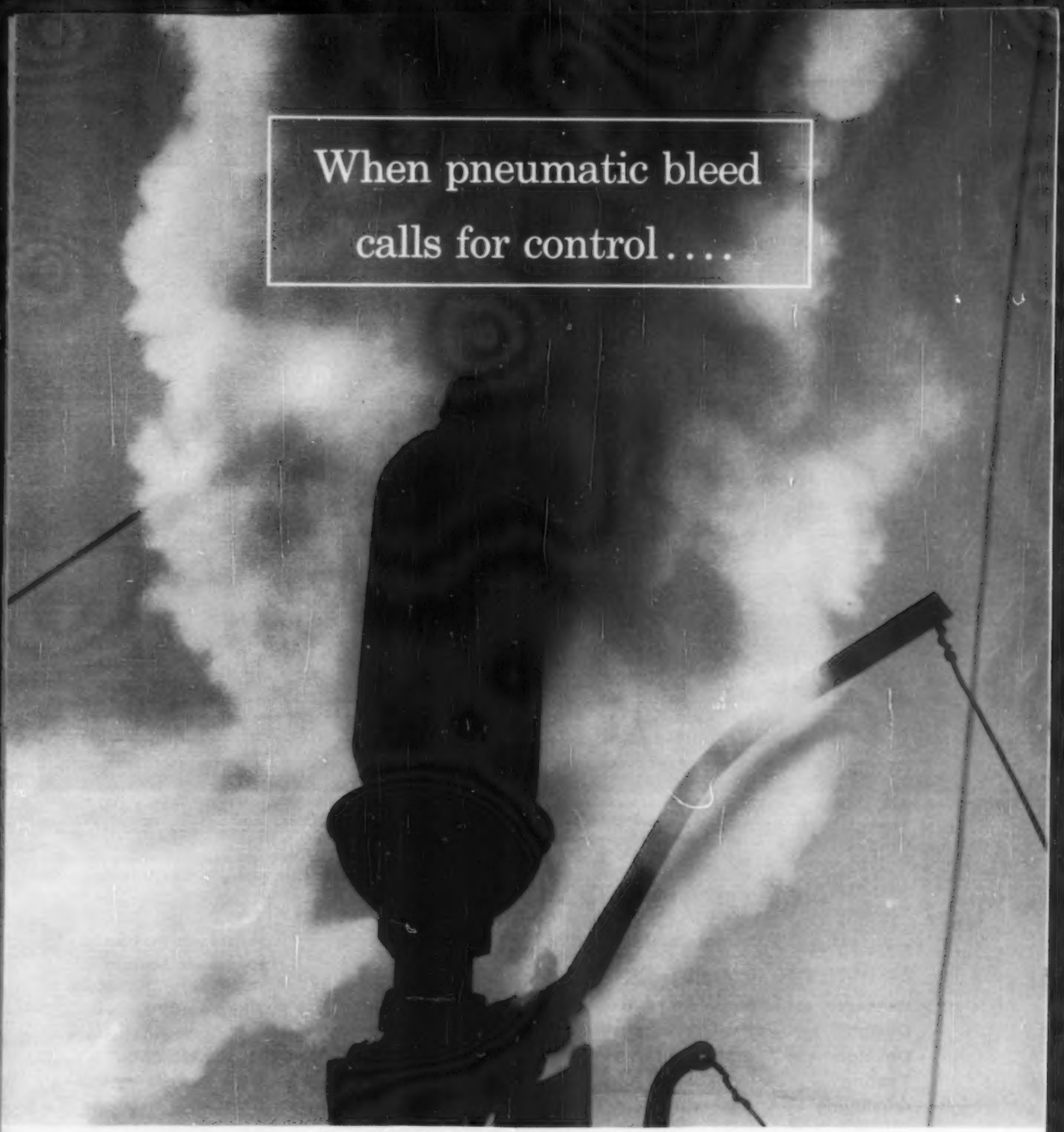

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AVIATION CALENDAR

July 25-27—Summer Board Meeting, American Assn. of Airport Executives, Clear Lake, Iowa.

Aug. 5—Regional Technical Meeting on Space Exploration, sponsored by American Rocket Society and the Institute of the Aeronautical Sciences. For details R. D. Linnell, General Chairman, Space Exploration Meeting, 3300 N. Harbor Drive, San Diego 1, Calif.

Aug. 6-8—Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, sponsored by the American Institute of Electrical Engineers, Hotel Statler, Los Angeles, Calif.

Aug. 7-8—Annual Conference, American Society for Quality Control, Western Region, El Cortez Hotel, San Diego, Calif.

Aug. 7-9—National Convention, OX5 Club of America, Hotel Statler, Los Angeles, Calif.

Aug. 7-15—Modern Developments in Heat Transfer, Continuation Course, University of Minnesota, Minneapolis, Minn.

Aug. 13-15—Conference on Electronic Standards and Measurements, National Bureau of Standards, Boulder Laboratories, Boulder, Colo. Sponsored by NBS, American Institute of Electrical Engineers and Institute of Radio Engineers.

Aug. 13-15—Seventh Annual Confercene, Industrial Applications of X-ray Analysis, Albany Hotel, Denver, Colo.

Aug. 17-23—Missiles Operations Research, Engineering Seminar, Pennsylvania State University, University Park, Pa.

Aug. 18-19—Annual Western Regional Meeting, American Astronautical Society, Dinkelspeil Auditorium, Stanford University, Palo Alto, Calif.

Aug. 18-20—Second National Heat Transfer Conference and Exposition, Edgewater Beach Hotel, Chicago, Ill.

(Continued on page 6)

AVIATION WEEK Including Space Technology

July 14, 1958

Vol. 69, No. 2

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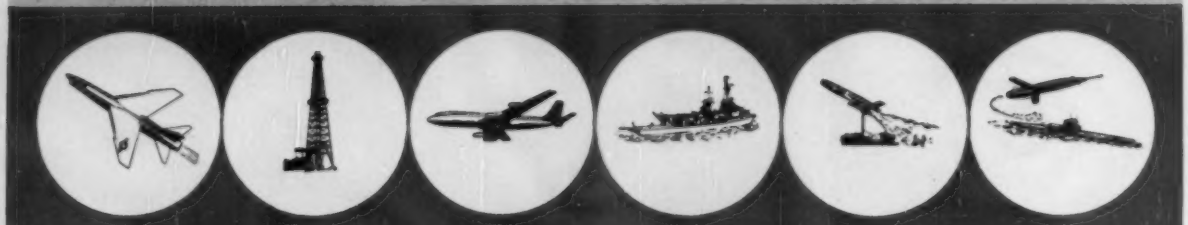

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AVIATION CALENDAR

(Continued from page 5)

Aug. 19-22—Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Aug. 25-27—Third Annual Convention, Nation-Flying Club Assn., Hollywood Roosevelt Hotel, Hollywood, Calif.

Aug. 25-30—Ninth Annual Congress, International Astronautical Federation, Amsterdam, Holland.

Sept. 1-7—1958 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 2-12—Problems of High-Powered Radar Design, Summer Program, Massachusetts Institute of Technology, Cambridge, Mass. (Security clearance required.)

Sept. 3-5—1958 Cryogenic Engineering Conference, Massachusetts Institute of Technology, Cambridge, Mass.

Sept. 8-13—First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain.

Sept. 9-11—Second National Conference on Applied Meteorology: Engineering, Ann Arbor, Mich. Program Chairman: Dr. D. J. Portman, 5500 East Engineering Bldg., University of Michigan, Ann Arbor, Mich.

Sept. 15-18—Fall Meeting, American Rocket Society, Inc., Hotel Statler, N. Y. C.

Sept. 15-19—Annual Instrument-Automation Conference & Exhibit (International), Instrument Society of America, Philadelphia Convention Hall, Philadelphia, Pa.

Sept. 22-24—1958 Meeting, Professional Group on Telemetry and Remote Control, American Hotel, Bal Harbor, Miami Beach, Fla.

Sept. 22-24—Seventh Annual Meeting, Standards Engineers Society, Benjamin Franklin Hotel, Philadelphia, Pa.

Sept. 22-24—1958 Convention of the National Business Aircraft Assn., Bellevue Stratford Hotel, Philadelphia, Pa.

Sept. 25-27—Fifth Annual National Western Forum, American Helicopter Society, Ambassador Hotel, Los Angeles, Calif.

Sept. 29-Oct. 3—National Aeronautical Meeting, Society of Automotive Engineers, Inc., the Ambassador, Los Angeles.

Sept. 29-Oct. 3—Semi-Annual Meeting and Western Tool Show, American Society of Tool Engineers, Shrine Exposition Hall, Los Angeles, Calif.

Oct. 6-7—National Symposium on Extended Range and Space Transmission, sponsored by the Professional Groups on Antennas and Propagation and Communications Systems of the Institute of Radio Engineers and George Washington University, Lisner Auditorium, Washington, D. C.

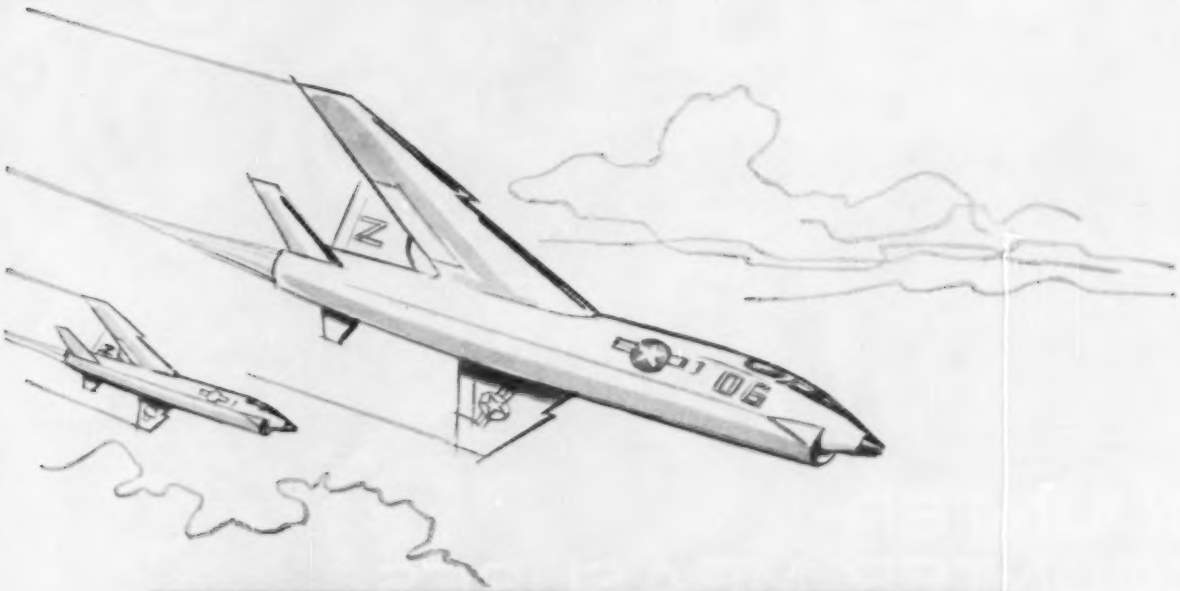
Oct. 7-8—1958 Joint Meeting, Institute of the Aeronautical Sciences and Canadian Aeronautical Institute, Chateau Laurier, Ottawa, Canada.

Oct. 22-24—Fifth National Vacuum Symposium, Sir Francis Drake Hotel, San Francisco, Calif.

Oct. 27—14th Annual General Meeting of the International Air Transport Assn., New Delhi, India.

Oct. 27-28—East Coast Conference on Aeronautical & Navigational Electronics, Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.

products that SEE by themselves . . .



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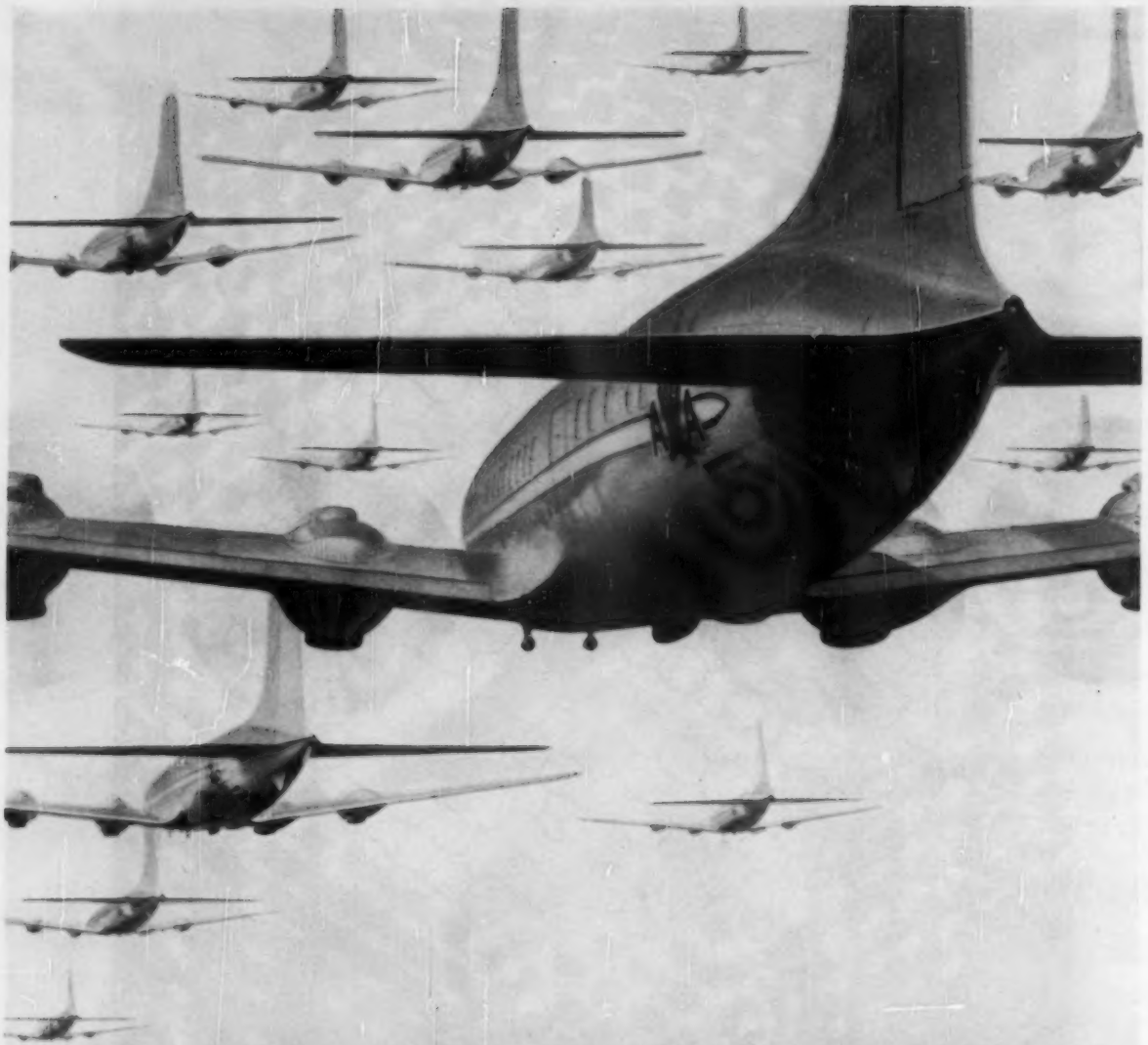

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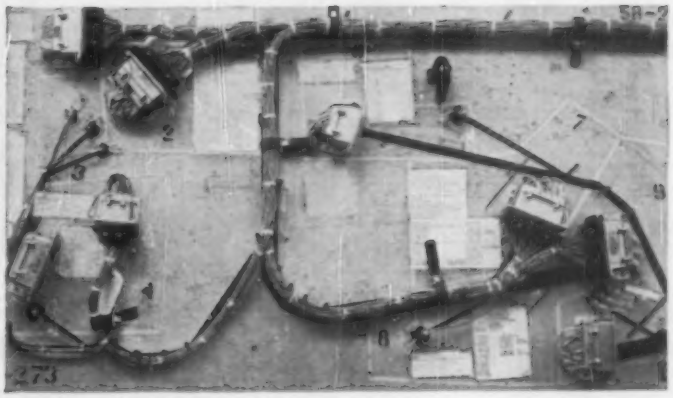
Convair's B-58 Hustler, supersonic delta-wing bomber. The B-58 is a high altitude craft, area-ruled for Mach 2 flight . . . capable of attaining altitudes above 50,000 feet. Now in production for USAF.

The PROBLEM

Insulation for the B-58's electrical wiring system must be flexible, solderable, withstand extreme temperatures, ozone, moisture, arcing, corona. Must meet MIL-W-8777 specifications. Wire bundle clamps must remain resilient under same extremes.



The PRODUCT

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SILICONE RUBBER

Wire covered with Silastic®, the Dow Corning silicone rubber, was specified throughout in the B-58. Wire bundle clamps are also Silastic.

TYPICAL PROPERTIES OF SILASTIC FOR WIRE

Temperature range, °F	—130 to 500
Insulation resistance, megohms/1000 ft.	1000 to 3000
Electric strength, volts/mil	300 to 500
Dielectric constant, 10^2 cycles per second, nominal	3.2

For more information write Dept. 097.

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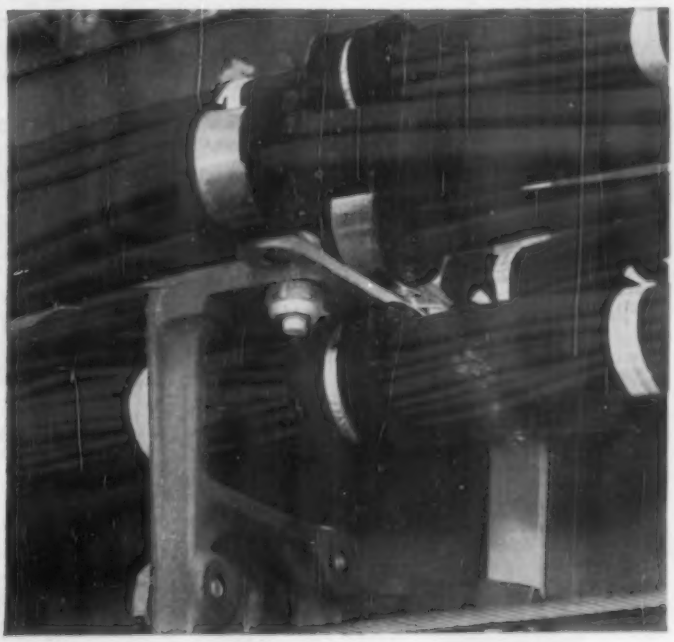

anti-jamming techniques pierce the shield of countermeasures

In the silent world of electronic defense, there are two ways to move and observe—unobserved. One involves the airborne jamming equipment LMEE is currently producing for the B-52. The other is the new Anti-Jamming techniques LMEE is currently developing for the Air Force to give future weapons systems a high degree of countermeasures immunity. Tomorrow's airborne weapons systems will need secure detection and reliable countermeasures. LMEE is intimately experienced in both. For brochure: "Moves and Countermoves in an Unending Struggle for the Electronic Spectrum," write Dept. F.

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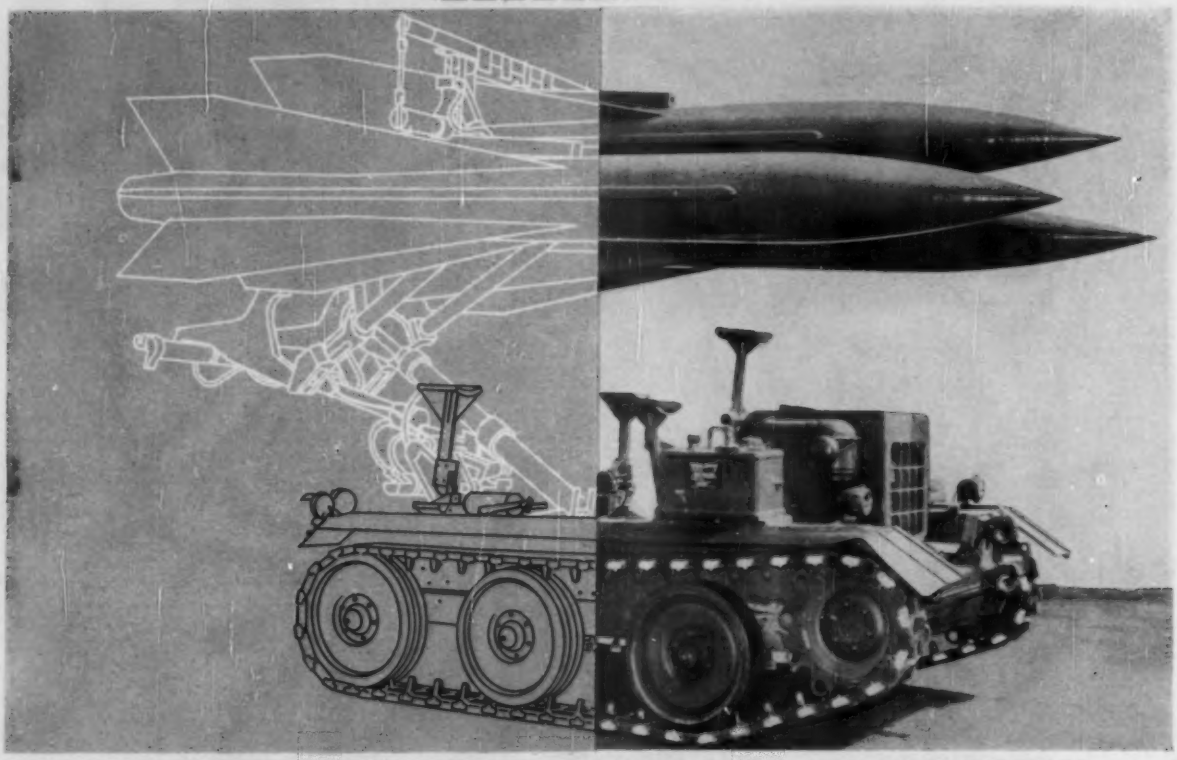

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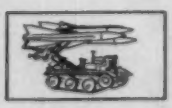
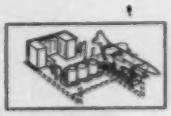


Transporter-Loaders

Launcher-Erectors & Power Units

Shipping & Storage Containers



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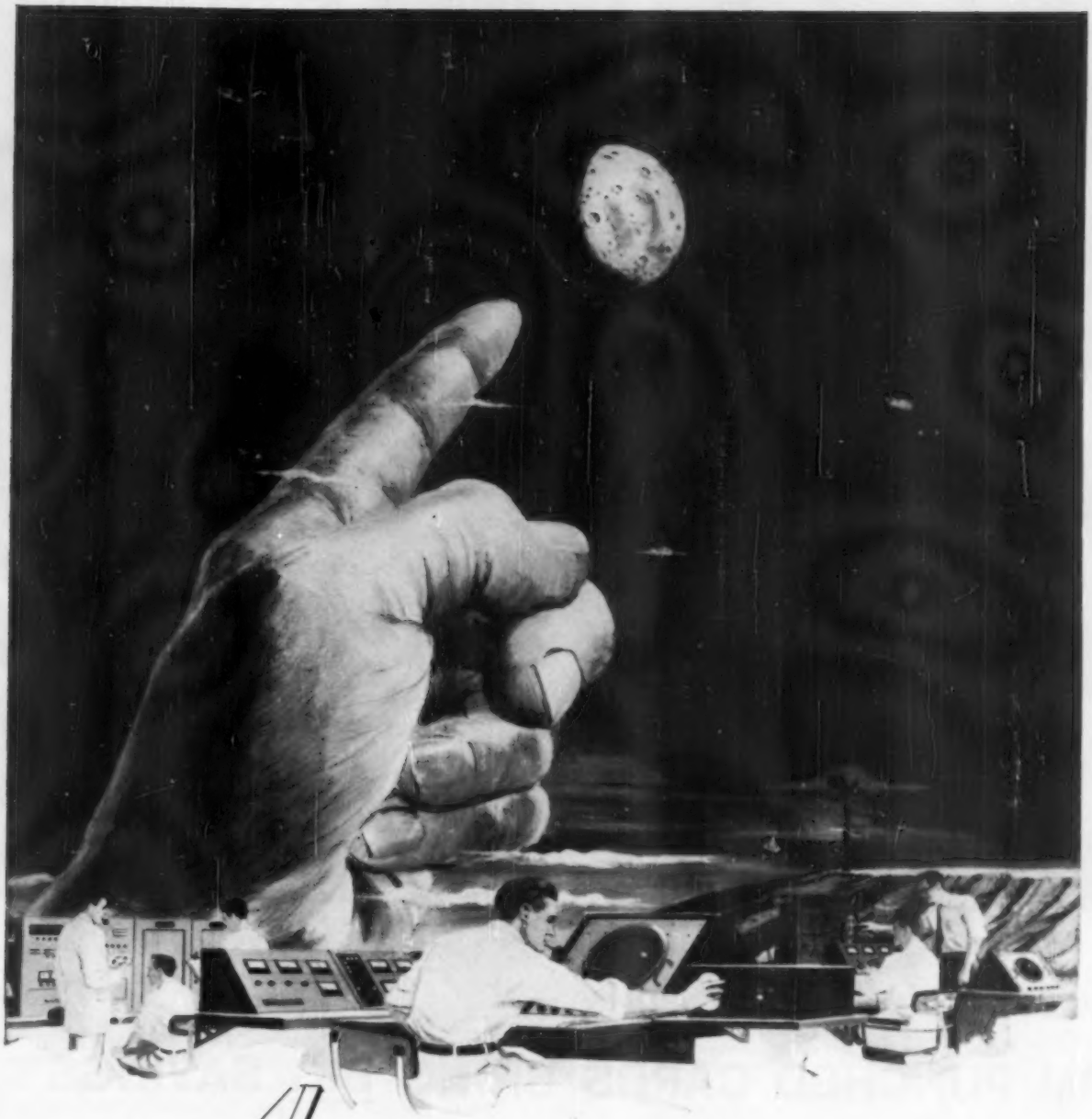

An advanced concept

The Singer Manufacturing Company announces the formation of its Military Products Division, which through its three functional units, Haller, Raymond & Brown, Inc., Diehl Manufacturing Company, and Singer Bridgeport Division, can efficiently handle complex electro-mechanical and electronic programs from concept to completion.

THE SINGER MANUFACTURING COMPANY

Military Products Division

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Q. **How do you use these punched cards?**

A. We punch customers' order information in the IBM cards and then we use the information over and over again to produce the documents and reports we require. This includes packing lists, invoices, accounts receivable, updated production reports and sales analysis.

Q. **Did you anticipate when you started that you'd be using the punched cards for so many areas of your business?**

A. To some extent. But what really surprised us was the speed and ease with which these documents and reports could be made available. We just have to punch the data once—and it's machine processed from there on.

Q. **Can you point to specific benefits of your IBM operation?**

A. Yes. Many. We were as much as a month behind in our statements. Now they're in the mail the first business day of each month even though now we are handling twice as many orders and twice as many shipments as we were before. We're able to advise our customers speedily and accurately of the status of their orders. In other words, we're *controlling* the business now; it's not controlling us.

CAMLOC REPORTS BENEFITS IN MANY AREAS...

RECEIVABLES: "Now we get every bill out the day after shipment—and we've added 25% to our working capital by bringing the funds in sooner."—Richard S. Wolff, President.

CUSTOMER SERVICE: "As soon as we put the IBM system to work the complaints ceased, the phones stopped ringing, customers were getting their shipments on time."
—Wm. E. Bracey, Sales.

BILLING: "Our clerical costs today would be four times as great without the IBM system."—Henry Cooper, Office Manager.

PRODUCTION: "Our records used to be from a week to a month late. Now we know what our requirements are for each week eight weeks in advance."
—Theodore A. Barkauskas, General Supt.

SALES: "We are able to give our field representatives analyses never before possible—as an automatic by-product of our billing."
—Wm. E. Bracey, Sales.

INVENTORY: "We've been able to reduce our investment in inventory by 10%."
—Richard S. Wolff, President.

IBM DATA PROCESSING

INTERNATIONAL BUSINESS MACHINES CORPORATION
590 MADISON AVENUE, NEW YORK 22, NEW YORK

Vital reports are produced with this compact IBM punched card installation for Camloc's Office Manager Henry Cooper, Wm. E. Bracey, Sales, and General Superintendent Theodore A. Barkauskas (l. to r.). Operating the key punch is Eleanor Frenzel.

IBM MANAGEMENT INTERVIEW

Mr. Richard S. Wolff, President, Camloc Fastener Corporation, Paramus, N. J.

For the world of small business –

IBM PUNCHED CARDS BRING BIG SAVINGS

"Electronic computers are fine for the larger companies, but what about us?" ask many small-company executives. "*We* need to cut paperwork costs and get information fast, *too*."

Here in an interview with key executives of a growing, progressive company you'll find the answer to that challenge—simplified IBM punched card methods that bring profitable results to many areas of one business.

The company is Camloc Fastener Corporation of Paramus, New Jersey, manufacturers of quick-operating fasteners for industry. The executives are: Richard S. Wolff, President, Theodore A. Barkauskas, General Superintendent, Wm. E. Bracey, Eastern Sales Manager, and Henry Cooper, Office Manager.

Q. Mr. Wolff, what were some of the problems you faced before you installed IBM punched card accounting?

A. Our growth was far outrunning our ability to control the operation. We couldn't get the information we needed to analyze sales or plan production. Invoices and statements were far behind. And as you might guess, customer service was suffering.

Q. Which of these areas would you say caused the most difficulty?

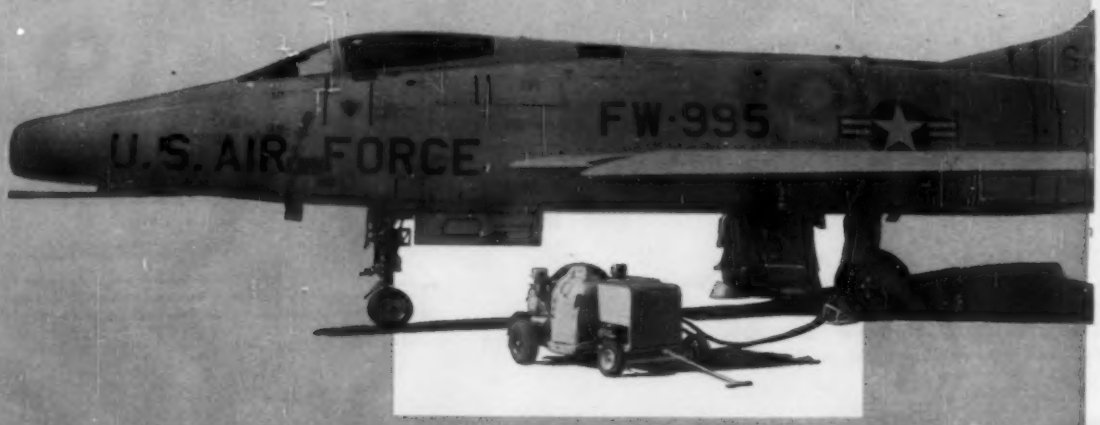
A. They're all tied together. We were trying to overcome the difficulties inherent in any manual system. Our business was expanding quite rapidly and we were running out of room in which we might put additional people. At this point, we decided to investigate machine accounting. We looked into several different types and found that IBM punched cards offered both the detail and control we needed.

VICKERS DEMONSTRATES NEW HYDRAULIC STARTER PACKAGE

As a part of its jet engine hydraulic starting system evaluation program, Vickers Incorporated recently demonstrated the ability of its starter package to start Century Series fighters. Acceleration to ground idle speed of the J-57 turbojet engine, installed in a production North American F-100D Super Sabre, was accomplished in times comparable to other known starting means... using only 50 horsepower, prime mover power.

Consisting basically of production Vickers aircraft hydraulic components... performance-proven on almost all existing U.S. military and commercial aircraft... the Vickers starting system offers substantial savings in weight, size, and cost — both initial and maintenance — over other known means. Available as either a ground mobile unit or an aircraft-installed airborne version, the Vickers starter package is capable of dual function. After engine starting, the hydraulic starter motor can serve as an engine-driven pump for aircraft auxiliary power requirements in the airborne version.

For further information regarding Vickers hydraulic starting systems, write for illustrated brochure SE-94a. Also, your nearest Vickers representative can show you the many system combinations available to meet your specific needs.



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July 14, 1958

Aviation Week

Including Space Technology

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COVER: Twin-turbine Vertol 107, freshly painted, takes off at Philadelphia, Pa., International Airport. Helicopter is powered by two Lycoming T53 turbines, although seven later models will utilize General Electric T58s (AW July 7, p. 78). Engines are side-by-side in rear pylon, shaft through fuselage tunnel turns forward rotor. External stubs at rear carry fuel, provide wide base for rear landing gear. Company has U. S. Army Transportation Corps order for 10 aircraft, three of which will be powered by Lycoming T53s.

PICTURE CREDITS:

26, 49—AVIATION WEEK; 34—Barnes Engineering Co.; 48—NACA; 54, 85, 59—Chance Vought; 71—General Electric; 75, 77, 79, 81—USAF; 79 (top)—University of Illinois; 81—Sperry Gyroscope; 90 (top)—Raytheon, Curtiss-Wright, RCA; 91 (top)—Thiokol; U. S. Army; 92—Grumman; 98, 99, 101, 103—Schweizer Aircraft Co.; 109—Sikorsky; 111—Klemm-Flugzeuge; 113—Oakland Airmotive.

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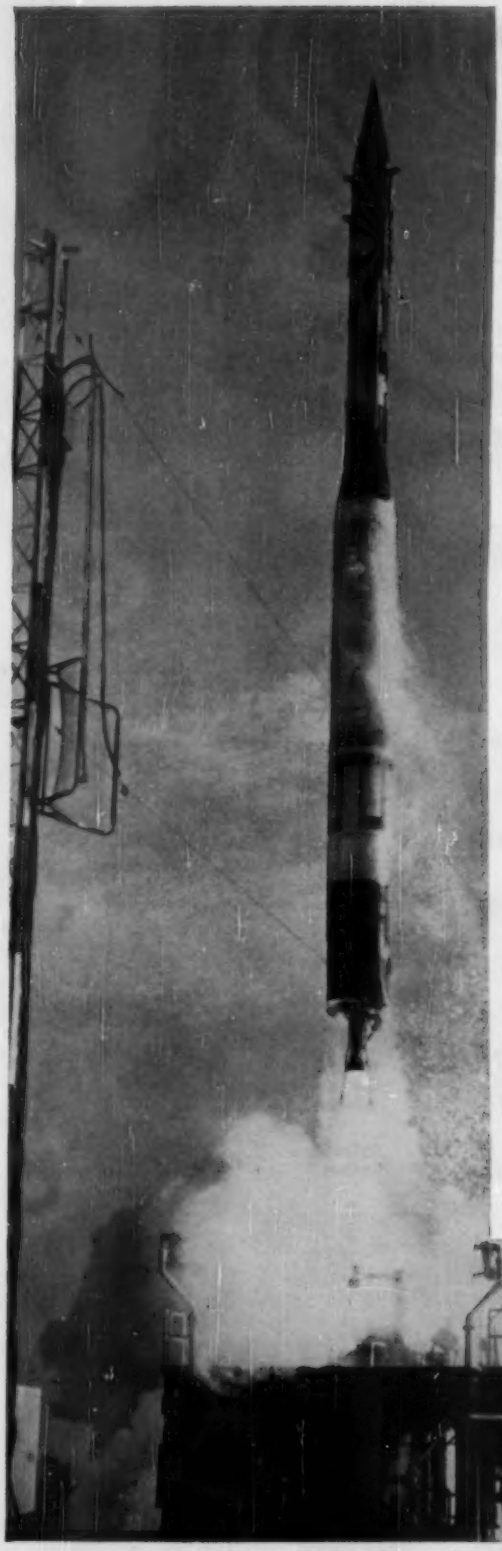

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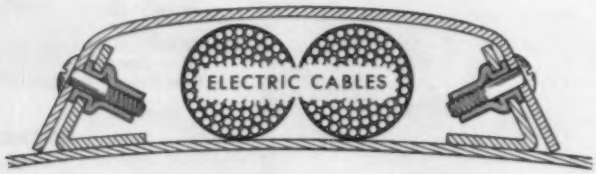

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EDITORIAL

MATS Needs an Overhaul

The Military Air Transport Service badly needs a basic overhaul to really perform the vital military airlift job required by the Army, Navy and Air Force for adequate logistic support in peacetime and for combat operations. MATS is not now providing either the type or quantity of aerial logistics required for the era of hydrogen weapons and supersonic delivery systems. Instead of concentrating on this vital task, MATS during the past few years has drifted into a flaccid pattern of bureaucratic growth that channeled its activities largely into duplication of the international air service already provided by civil airlines in a much more efficient manner.

We have always fought hard for an adequate, modern military aerial logistics system. We have had some experience in this field and believe it is a vital and badly neglected ingredient in any successful combat pattern that may emerge in the foreseeable future. Back in 1942 we served a year with one of the first four-engine international transport operations of Air Transport Command. For the next three years we lived and fought in China at the end of the world's first and still most fantastic aerial supply line across the Hump from India. As a reporter we covered the Berlin Airlift and the combat cargo operations of the 315th Air Division during the Korean war. More recently, we have studied the emergence of a new pattern of aerial logistic support in Europe and North Africa with the turboprop-powered Lockheed C-130. We know most of the men who have been laboring hard in this field during the past decade with little top-level USAF support or true appreciation of the aerial logistics problem. The tragic experience of the British and French at Suez and the cumbersome air movement of British troops to Cyprus in recent weeks are fresh reminders of the necessity of large scale high speed mobility in both hot and cold wars.

The recent congressional investigations of MATS have shed some revealing light not only on the aerial logistics problem but also on the attitude of the Pentagon toward civil aviation. We were appalled at the calloused indifference of top USAF officials who testified before Congress toward the vital role of civil air transport in the nation's economy and toward the economic problems of a civilian air transport industry on which the military depends in time of emergency. USAF badly needs to revise its basic attitude toward civil aviation not only in the role it plays in air logistics but also in such vital matters as developing an adequate common air traffic control system.

We agree wholeheartedly with the recommendations of the House Military Operations Subcommittee headed by Rep. Chet Holifield of California outlining the areas in which MATS current practices need overhauling. MATS today is operating a fleet of some 400 four-engine transports and is the largest air transport operation in the world. The bulk of its fleet is of the same type of aircraft operated by commercial airlines. It also duplicates the commercial airline routes over many of the highest density international traffic routes. All this type of MATS operation does is prove that military air transport cannot move passengers and conventional cargo with anything approaching the efficiency or economy of commercial transport operations.

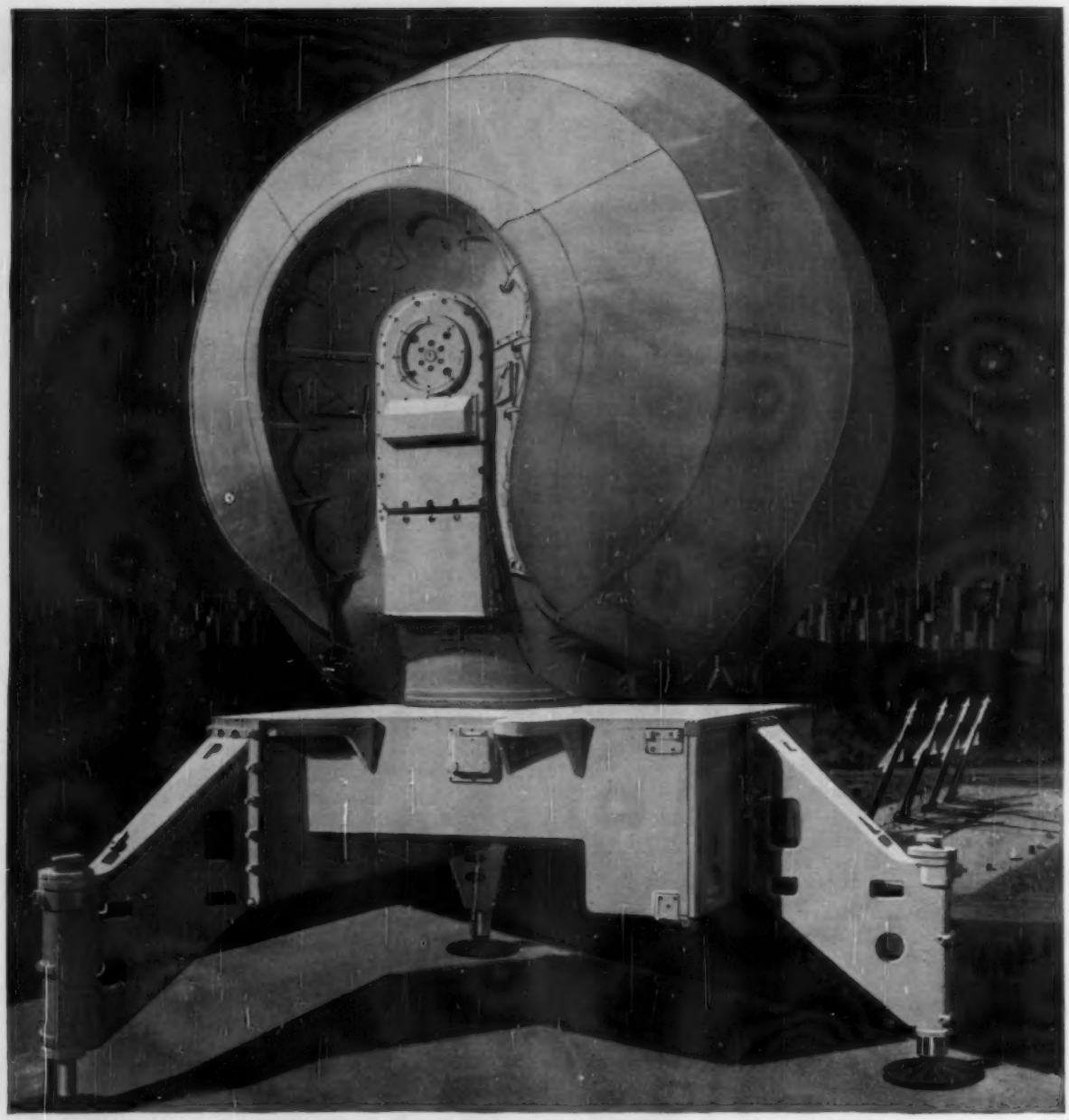
If anybody needs proof of this, they should take a look at MATS current "Blue Plate" flights between New York, Paris and Frankfurt, paralleling a major commercial transatlantic air route. MATS gets about 42 passengers into its equivalent of a DC-6, sprawling ten luxurious seats in a VIP lounge and squeezing three-abreast seating in odd combinations through the remainder of the cabin. The galley, where meals are prepared in a tortuous operation that takes hours, weighs more than a ton. One whole side of the fuselage aft of the cabin door is occupied by this galley and a combination garbage bin and coat rack. In contrast to the flight operations which are most efficient, this passenger service of MATS is a burlesque of economic air transport. According to testimony before the congressional investigating committee, MATS overseas passenger traffic in the 12 months ending June, 1957, totaled more than 57% of all U. S. flag airlines' foreign traffic, and MATS cargo and mail tonnage was more than triple the amount carried by U. S. flag airlines overseas and surpassed even the total of all cargo and mail tonnage of all the U. S. domestic airlines for the same period. This is a good measuring stick with which to gauge just how far MATS has strayed from its original purpose.

MATS is now attempting to justify its huge duplication of civil airline operations by clinging to the coattails of Strategic Air Command. We find it hard to imagine what the 480 enlisted personnel employed by MATS as airline-type stewardesses contribute to SAC logistic support and note that SAC has 100 multi-engine transports of its own to provide the vital airlift it requires in support of its mobility pattern. The type of airline operations that now make up the bulk of MATS operations contribute little to genuine SAC support.

MATS is getting a change in command next month when Lt. Gen. William Tunner leaves the Pentagon to take charge. Gen. Tunner has a brilliant record in developing and operating aerial logistic systems going back to the Hump of World War II and continuing through the Berlin Airlift and the Korean combat cargo operations.

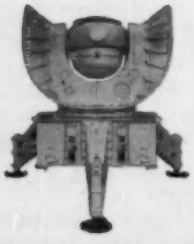
We hope he will be the man to give MATS the thorough overhaul it so badly needs to get back in the business of pioneering the new techniques of aerial logistics that Strategic Air Command, the Army and Navy need to meet the stiff requirements of combat in the supersonic era.

—Robert Hotz



big ears of Nike Hercules

Mounts for radar antennae used by the U. S. Army's Nike Hercules to track aerial intruders and guide the deadly Nike missiles that strike them from the sky are products of the integrated manufacturing and engineering skills of Kelsey-Hayes, working in close cooperation with Western Electric. Capabilities range from prototyping to final production. The Speco Division is one of seven Kelsey-Hayes Divisions devoted to the production of aircraft and missile components.
Kelsey-Hayes Company, General Offices: Detroit 32, Michigan.



Nike Antenna Mount produced by Speco Division of Kelsey-Hayes requires over 2,000 individual parts, many of which are machined to a tolerance of less than two ten-thousandths of an inch.

KELSEY-HAYES

AVIATION DIVISIONS, KELSEY-HAYES CO., DETROIT 32, MICHIGAN

22 PLANTS: Detroit and Jackson, Michigan; Los Angeles; McKeesport, Pa.; Springfield, Ohio (Speco Division); Utica, New York (Utica Drop Forge & Tool Division); Davenport, Iowa (Farm Implement and Wheel Division); Philadelphia (Heintz Division); Clark, New Jersey (New Jersey Division); Windsor, Ontario, Canada.

WHO'S WHERE

In the Front Office

Henry Arnhold, board chairman, and **John Bouwmeester**, president, General Ceramics Corp., Keasbey, N. J.

William Naden, president, Esso Standard Oil Co., New York, N. Y. Mr. Naden succeeds **Stanley C. Hope**, retiring.

Glenn H. McIntyre, president and treasurer, National Spectrographic Laboratories, Cleveland, Ohio.

William P. Munger, president, Hydel, Inc., Cambridge, Mass.

Carl R. Wetterau, president, Flight Support, Inc., Metuchen, N. J.

Gregory S. Coleman, vice president and a director, Alloys Unlimited, Inc., Long Island City, N. Y.

Gerald J. McCaul, acting executive vice president, Simmonds Aerocessories, Inc., Tarrytown, N. Y., assuming the responsibilities of the late William R. Enyart, company president. **William E. Berchtold**, board chairman, will preside as chairman of the Management Committee.

Moody Besancan, vice president-Eastern Division (headquarters in Washington, D. C.), Babcock Radio Engineering, Inc., Costa Mesa, Calif. Also: **Norman Cima**, assistant vice president-sales engineering.

Donald C. Grefe, vice president and managing director, Eastern Air Lines, S. A.

J. H. Dalton, vice president-finance, Servo Corporation of America, New Hyde Park, N. Y.

Rear Adm. Selden B. Spangler (USN, ret.), director of research, The Garrett Corp., AiResearch Manufacturing Division, Phoenix, Ariz.

Sir Mark Norman, secretary, Bristol Siddeley Engines, Ltd., London, England.

Honors and Elections

Lt. Gen. Donald L. Putt (USAF ret.) has been awarded an honorary fellowship in the Canadian Aeronautical Institute for his "outstanding work in research and development in aeronautical engineering. . . ."

Leo Young, Westinghouse electronics engineer, has been chosen as the 20th recipient of the Benjamin Garver Lamme graduate scholarship. The Lamme graduate scholarship was established in 1927 as a memorial to the former chief engineer of Westinghouse.

Socony Mobil Oil Company, Inc. has received an Award of Merit from Flight Safety Foundation in recognition of the company's ". . . interpretation of the influence of weather on safety in flight through . . . displays in the aviation press."

Walter M. Hartung, vice president of the Academy of Aeronautics, LaGuardia Airport, has been elected president of the National Council of Technical Schools.

A. F. Burke, chairman and managing director of the de Havilland Aircraft Co., Ltd., has been elected president of the Society of British Aircraft Constructors for 1958-59. **Sir George Dowty**, chairman and managing director of the Dowty Group of company, was elected vice president. **C. F. Uwins**, SBAC president in 1956-58, becomes deputy-president.

(Continued on p. 95)

INDUSTRY OBSERVER

► New version of Navy Bullpup air-to-surface missile which Martin is developing for Tactical Air Command (AW June 23, p. 15) can carry either nuclear or conventional warhead and is expected to have extremely high accuracy.

► Failure of Talos ground-to-air missile to destroy its B-17 drone target during recent Army missile demonstration at White Sands, N. M., was due to premature detonation of the warhead by a malfunctioning proximity fuze five seconds before interception. Both warhead and proximity fuze were experimental models. Fuze is being developed by Melpar, Inc. Navy-developed ramjet missile was launched from land-based Talos defense unit delivered to the Army by Radio Corp. of America for evaluation. First official statements on the failure said the warhead failed to explode.

► Direction of exhaust nozzle blast on Aerojet-General solid propellant engine for Navy's Polaris fleet ballistic missile is controlled by a vane known as a Jetavator. Vane is supported by bushings incorporating stainless steel split inner ring enclosed in Met-L-Flex knitted Inconel housing manufactured by Robinson Aviation Corp. to accommodate forces of thermal expansion.

► Thrust of Polaris fleet ballistic missile is terminated by blowing ports in forward end of combustion chamber. This cuts off thrust "almost instantaneously." Polaris has single grain of solid propellant in each of two stages, four exhaust nozzles in first stage.

► In overwater flight trials, Lockheed Electra turboprop, which Navy plans to use as anti-submarine warfare aircraft, cruised at low level using only two inboard engines. Power was then cut to zero on one engine to simulate powerplant failure, airspeed was allowed to decay gradually for approximately five minutes. One outboard was then cut in to continue the flight on two engines.

► Air Force's Green Quail diversionary missile intended for launching from B-47s and B-52s has slipped about six months from earlier production schedule because of delays in the General Electric J85 engine. General Electric spokesmen say no serious problems are involved. McDonnell Aircraft Co. is prime contractor for the missile.

► Although both Norway and Denmark have refused to accept atomic weapons from NATO, both countries will be equipped next year with several delivery systems capable of using nuclear weapons. Norwegian and Danish Air Forces next summer will begin conversion to North American F-100D fighter bombers equipped to handle nuclear weapons and capable of training pilots in low-altitude delivery techniques without live weapons. Norway and Denmark also will get a battalion of Nike air defense missiles with both Ajax and Hercules models. The Hercules model is designed to take an atomic warhead.

► First two gantries for Martin Titan intercontinental ballistic missile are near completion at Air Force Missile Test Center, Cape Canaveral, Fla. Disconnect pole for a third facility is up, and a fourth pad is almost finished. Erectors have a shorter section built out from main section that look like giant steps when upright and enable both stages of missile to be put side-by-side for static firing separately. Erectors are raised and lowered hydraulically. First Titan probably will arrive at Canaveral next month. It will not be launched but used to test out electronic checkout equipment and other facilities.

► Reliability of Atlas intercontinental ballistic missile should be improved through use of recently developed single gas generator and single pump which can supply propellant to both booster and sustainer engines, replacing individual gas generators and pumps formerly used.

► Air Force decision as to whether to accelerate its nuclear-propelled aircraft program will depend upon results of current series of engine tests now under way at Idaho test station.

Washington Roundup

Radford Protest

Adm. Arthur Radford, former chairman of the Joint Chiefs of Staff, fired on all three services last week for going their own ways at the closing session of Senate Armed Services Committee on proposed legislation to reorganize the Defense Department. "I am very disappointed in the way the services have cooperated with the Secretary of Defense" in cutting out duplicating weapon systems, he told the committee.

Less compromising than Defense Secretary Neil McElroy, Radford firmly backed the President's opposition to three provisions contained in the reorganization plan by the House (AW June 9, p. 17). McElroy expressed a willingness to go along with one of the provisions, which specifically authorizes the services secretaries and chiefs to present minority views to Congress. The other two provisions provide that changes in major combatant functions be subject to veto by Congress and that the Secretary of Defense should exercise his authority through the individual service secretaries. Radford said he doubted that the President's plan went far enough in up-grading the role of the Secretary of Defense and down-grading the roles of the services. Gen. Carl Spaatz, former USAF Chief of Staff, agreed. Adm. Robert Carney, former chief of naval operations, however, opposed even the House measure, saying that no reorganization legislation is needed. Adm. Arleigh Burke, chief of naval operations, previously backed the House measure.

In Congress

Other action in Congress last week included:

- **Senate Commerce Committee voted legislation** establishing a five-member commission of technical experts to make a study of the increasing competition for use of radio frequencies between Civil Aeronautics Administration, the military services, Federal Communications Commission and other government agencies.
- **Sen. Glenn Bell (R.-Md.)** introduced a measure requiring that 60% of the funds used by the military services for the repair and overhaul of aircraft and missiles be let to private industry.

Poor Outlook

Air Force Assn. plans to hold its 1959 convention in Miami over the Labor Day weekend virtually kills any possible attempt to revive the now defunct National Air Show which formerly relied upon the Labor Day spot. Neither Defense Department nor aircraft industry could support two major air shows at that time.

Incompetence

Incompetence of some Pentagon officials who have the final say over industry and service requests for declassification of information was highlighted recently in the shop of Defense Department missile czar William Holaday.

At stake were a series of pictures of the Nike Hercules which Army and a contractor wanted to release in connection with Army's missile show at White Sands, N. M. (AW July 7, p. 36). The pictures passed routinely through regular Defense Department security review channels, then went to Holaday's office for final review. There, the request was flatly denied on the grounds that the pictures showed radar units which would provide a valuable clue to the Hercules' capability.

After contractor's representatives had patiently explained that the same radar units were at the missile site when it was equipped with the earlier Nike Ajax, the request was again denied. The new reason: The "knobs" shown protruding from the roof of a building in the pictures would give away the number of targets the missile site could handle simultaneously.

The official finally relented when it was explained that the "knobs" were ventilators.

Nickerson Restored

Col. John C. Nickerson, court-martialed last year for leaking secret information in an overzealous attempt to promote Army's missile achievements and minimize those of the Air Force, officially emerged from the Army doghouse last week. Restored to full authority, Nickerson took over as ordnance officer of the United States Army Caribbean Command with headquarters in the Panama Canal Zone. His court martial sentence had deprived him of command authority for a one-year period. He had spent the year inspecting construction work at Fort Amador, Canal Zone. At the time of his court martial, Nickerson was chief of the field coordinating office at the Army Ballistic Missile Agency, Huntsville, Ala.

Federal Aviation Delay

Outlook is that it will be several weeks before Congress enacts legislation establishing an independent Federal Aviation Agency (AW June 30, p. 30). Senate's agenda is jammed with high-priority measures. The House Commerce Committee is entangled in its investigation of Boston textile manufacturer Bernard Goldfine, and it is not known when the committee will get around to consideration of the FAA measure. A subcommittee tentatively closed hearings last week.

Only point of strong controversy appears to be over the selection of missile bases. The measure approved by Senate Commerce puts the decision with the FAA administrator. Sen. Andrew Schoeppel (R.-Kans.) insists authority should be left to the Secretary of Defense. One compromise would place it with the President.

Legal Roadblock

Attorneys for United States Overseas Airlines have encountered another roadblock in their efforts to obtain service in a $3 million damage suit against Pratt & Whitney Aircraft Division of United Aircraft. First rebuff came several months ago when papers were mistakenly served upon a different firm, the Pratt & Whitney machine tool company of East Hartford, Conn., headquarters of United Aircraft.

The suit was later filed in the U. S. District Court of the District of Columbia and notice served upon a company representative in Washington. Last week, United attorneys moved to have the suit dismissed on grounds that the representative had no authority to accept the service and that United does not engage in business in Washington. The airline has charged Pratt & Whitney with violations of anti-trust laws and discrimination for allegedly allowing certificated carriers discounts of 40% on purchases and only 20% to supplemental carriers.

—Washington staff

A project of Colonel Edward A. Allen (USA Ret.)
Senior Staff Engineer, Stavid Engineering, Inc.

In 37 years of military service, Colonel Allen has contributed greatly to the evaluation and development of all types of communications equipment for the Army Signal Corps. Currently assigned to Project Monmouth III, Colonel Allen serves on a board to resolve communications and spectrum interference problems associated with the modern dispersed field army. Like other outstanding scientists and engineers at Stavid, Colonel Allen is working on advanced concepts . . . years ahead of actual systems development.

In Stavid's objective engineering atmosphere, scientific, development and manufacturing teams are producing a wide range of electronic systems for the Services. A current project, for example, calls for the development and manufacture of the Mark 70 Gun Fire Control System.

OTHER STAVID PROJECTS INCLUDE:

- LANCE Weapon System
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perature operation and its specific air flow and specific fuel consumption will be improved, leading to improved performance at altitude.

Components Evaluated

Some components of X279 now are being evaluated, but a test run of the complete engine still is not imminent. The engine probably will be taken aloft for trials sometime before the end of 1960 in a Convair B-58 flying test bed, and a 50-hr. qualification test probably will be completed in 1961, giving it a YJ93 label. This engine then could be used as the powerplant for F-108 or B-70 flight test articles.

Fundamental difference between current operational turbojets and development high Mach number engines, such as the X279, shows up in compressor configuration. For example, General Electric's J79 Mach 2 turbojet engine, now flying in Lockheed's operational F-104A, Grumman F11F-1F and Convair B-58, is designed for subsonic cruise (Mach 0.9) and supersonic combat and dash capability, with a 17-stage compressor affording 12.5 to 1 pressure ratio. By comparison, in high Mach number turbojets, most of the pressure rise will be in ram recovery at inlet. With sufficient pressure rise, ram effect is substituted for compressor staging so that the compressor will not be large.

General Electric's X279 will have a very high compressor inlet pressure because of ram. Relationship of this pressure to the compressor's last stage pressure value is a multiplier, so that it is certain that the X279 compressor will have a sharply reduced number of stages in comparison with the 17-stage J79. Otherwise, high ram pressure coupled with high pressure ratio of a many-stage compressor would create a temperature value at final compressor stage almost equal to the desired turbine inlet temperature, which would leave no latitude for burning. X279's compressor discharge temperature probably will approximate that of the turbine inlet temperature of General Electric's old J47 turbojet engine. Emphasis will be placed on new materials in the compressor, turbine and afterburner.

Diameter of X279's afterburner exhaust, estimated to be about 5½ ft., will be relatively large in comparison with the compressor inlet diameter.

Fuel Selection

Basic performance of X279, and probably other Mach 3 turbojet engines now under development, will be premised on the use of standard JP-type fuels, in a sense making the "chemical bomber" designation a misnomer. However, these engines are being projected to use high energy fuels if these are eventually available in sufficient quantities.

It has been estimated that a group of 30 chemical bombers might require 105,000 tons of boron fuel per year, provided the high energy fuel were used only about 25% of the time. One of the first high energy fuels likely to be used in F-108 and B-70 afterburners is an alkyl-borane type releasing about 25,000 Btu/lb., compared with average heating value of 18,600 Btu/lb. for JP-4.

Corrosive action of high energy fuel probably will make it inadvisable to burn it in the turbojet engine proper, thus limiting its use to the afterburner.

Also, with higher Mach numbers there is little difference whether this fuel is burned before or after the turbine, with respect to cycle propulsion efficiency.

Limiting the use of high energy fuel to the afterburner also will simplify mechanical problems.

Afterburner for the X279 is being designed to accommodate the broad possibilities of high energy fuel development which can be anticipated now, but it is likely that certain high energy fuels which may be developed after the engine (J93) becomes operational may require new afterburner design.

To take advantage of high energy fuel use in Mach 3 turbojet engines for transport application, engines probably will have to be tailored to minimize corrosive effect, since burning of this fuel would be in the engine proper, because no afterburners would be carried by transports.

Flight Strategy

Flight scheme for Mach 3 aircraft probably will use very fast acceleration to altitude to conserve fuel.

Military aircraft probably would use high energy fuel in the afterburner from the start of straight and level cruise.

Working arrangement between North American Aviation and General Electric is an unusually close one to ensure that X279 development will match F-108 and B-70 requirements. Extremely close liaison is maintained during the concurrent phases of development.

North American's wind tunnel data is collated with General Electric's test data and engine modifications are fed in where possible to meet requirements.

Probably the most critical operational requirement for Mach 3 aircraft will be embodied in the B-70 bomber because it is designed to cruise at this high supersonic speed for intercontinental ranges. Concept and design of the entire WS-110A chemical bomber weapon system underscores two fundamental approaches to ensure top effectiveness:

• **State of bomber progress** is being advanced as far as possible within the time scheduled for introduction of the weapon.

• **Every aspect** of the system—B-70 bomber, all associated and supporting equipment—will be clearly within the operational capability of crews of Strategic Air Command. In this Mach 3 weapon, the Air Force is putting emphasis on man being the most reliable mechanism.

B-70 Characteristics

The B-70 bomber will usher in unusual characteristics and stringent operational requirements:

• **Steady-state-cruise** actually will be in excess of Mach 3 for the plane's entire intercontinental mission. Higher Mach number dash speed could have been designed into the B-70 potential but this would mean that the entire plane—structure and powerplant—would have to be designed to withstand higher temperatures generated by the dash condition, and increment of speed gained might not justify engineering refinements which would have to be achieved.

• **Cruise altitude** may be as high as 50,000 ft.

• **Range will be** over 7,000 mi. at 70,000 ft. at Mach 3 using boron-base high energy fuel.

• **Gross weight,** originally scheduled for 500,000-550,000 lb., may grow to 600,000 lb., but the airplane will have to use existing runway facilities.

• **Payload-to-gross** weight ratio will be approximately 4.5 to 5%.

• **Crew of four** will have unusual protection for maximum capability to continue mission in event of damage.

• **Fuselage is boxy,** has very high fineness ratio and long nose. From a point well forward, the fuselage body sweeps up to the top of the engine inlets on the underside of rear of plane, minimizing flow interference to central portion of engine inlet areas. Starting at the junction of the fuselage and wing leading edge, the body is necked, then fans out as it continues aft.

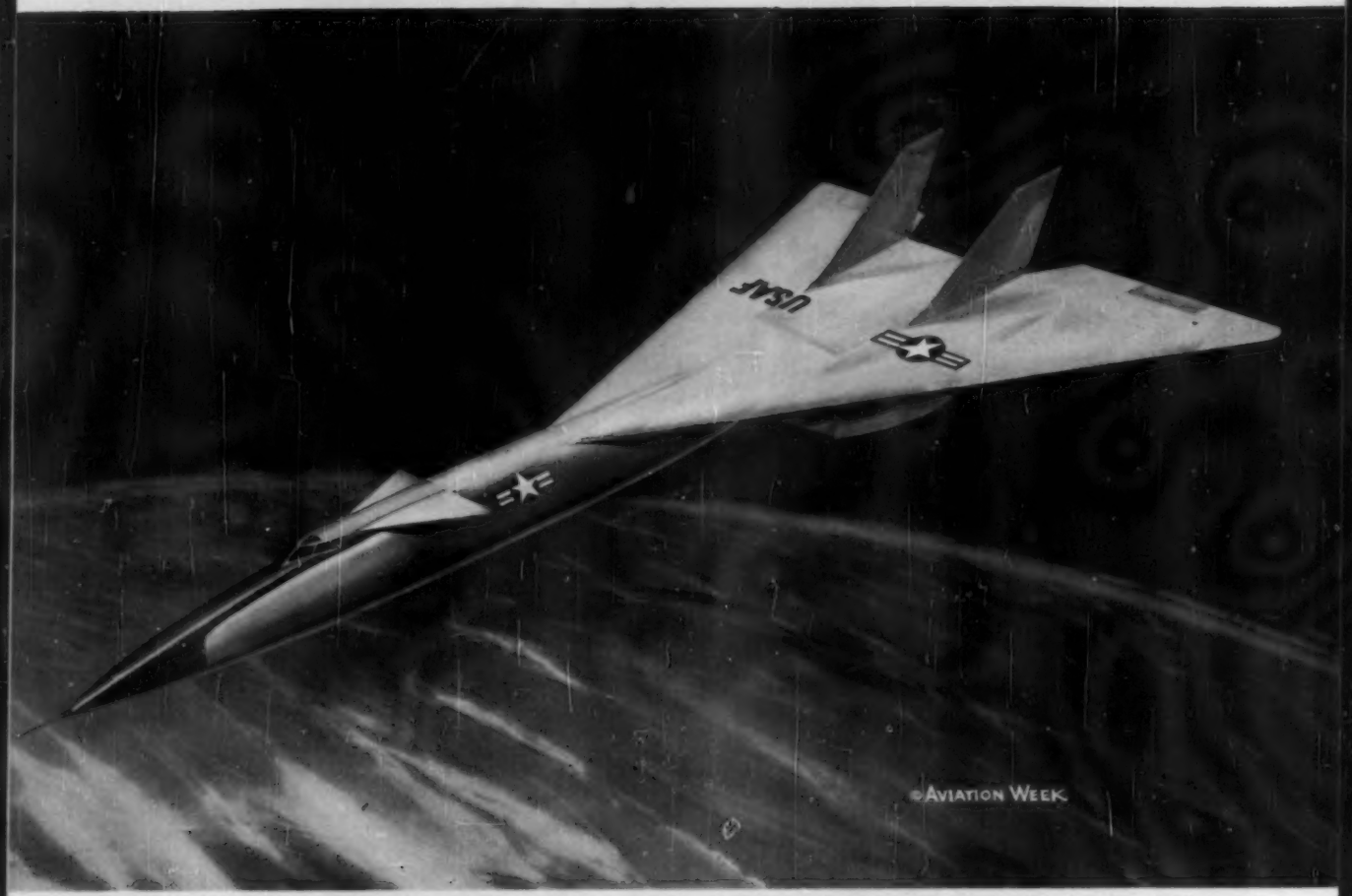
• **Canard horizontal tail** is mounted high just aft of crew compartment, sweeps back at an angle of about 60 deg.

Canard configuration was selected for aerodynamic advantages at the airplane's cruise speed and for favorable weight distribution.

• **Delta wing** has about 60 deg. sweep, meets fuselage somewhere between middle and top levels. Wing trailing edge has substantial cutout in middle one-third of span, above turbojet exhaust nozzle area.

• **Vertical tail surfaces** are mounted at each side of wing trailing edge cutout area.

• **Six General Electric J93** turbojet en-



NORTH American Aviation B-70 Mach 3 bomber will be powered by six General Electric J93 turbojets in lateral pack under delta wing.

Mach 3 Manned Aircraft Designs Pushed

Three main types include B-70 'chemical bomber,' transport aircraft and F-108 long range fighter.

Washington—Aircraft industry is pushing into the next generation of manned aircraft, into designs capable of steady state cruise at Mach 3.

Three general classes of Mach 3 aircraft now are being designed:

- **B-70 "chemical bomber,"** included in North American Aviation's WS-110A weapon system. This project now is in Phase I, mockup is being readied, and work is being pushed towards production of a number of flight test articles.
- **F-108 long range interceptor,** included in North American Aviation's WS-202A weapon system. Farther along than the WS-110A system, this project contemplates production of two F-108s in 1960, six in 1961 and seven in 1962.
- **Supersonic transport.** Mach 3 aircraft are being projected by major U. S. transport builders. No detailed design for these aircraft has been undertaken, but concepts have been formulated, wind tunnel research done, economic factors studied and problems peculiar to high speed transportation evaluated.

Advanced Turbojet Design

One of the biggest technical jumps which makes possible the Mach 3 aircraft is advanced turbojet engine design. Companies engaged in development of Mach 3 turbojet engines include General Electric, Pratt & Whitney Aircraft and Rolls-Royce. Any one of these three designs might be selected for transport application, but General Electric's J93, now designated X279, has been picked to power North American's Mach 3 F-108 interceptor and B-70 bomber.

Originally, General Electric on its own responsibility had projected two versions of the advanced turbojet—one a "small" engine known as X275, the other a larger, higher thrust version labeled X278. Industry survey initially showed preference for general use of two of the small X275s instead of a single large X278. But as characteristics of the X275 were re-evaluated in a continuing analysis of requirements, the engine gradually "grew" until General Electric decided it would be better to concentrate on a large engine, which was designated X279.

Initially, General Electric proposed basic X279 for North American's F-108 long-range interceptor and an advanced version of the X279 for company's B-70 bomber design. Subsequently, an advanced version was suggested for both aircraft to accelerate development because the F-108 would be introduced earlier.

Final decision involves basic X279 "with improvements" for the F-108, and an "advanced" version of X279 for the B-70.

Both engines will be similar in size. Basic components will be approximately the same, but the advanced version in the B-70 will be slightly heavier. Its turbine will be modified for higher tem-

Stever Group Urges USAF R&D Shift

By J. S. Butz, Jr.

Washington—Broad reorganization and changes in management procedures to bolster basic Air Force policy and improve direction of its research and development programs have been proposed by the ad hoc Stever Committee of the USAF Scientific Advisory Board.

The committee, headed by H. Guyford Stever of the Massachusetts Institute of Technology, surveyed the research and development program at the request of Gen. Thomas D. White, Air Force chief of staff. Major reorganizations and policy changes that the committee considers essential include:

• **Air Force must make its** R&D policies and requirements clear to higher authority, industry and the public.

• **Authority to act must be returned** to the lower working levels of the Air Research and Development Command, reversing the present tendency of concentrating power in the highest echelons of the Air Force. Committee feels this type of management is prevalent in the government and violates one of the first requirements of the good executive who must be able to delegate authority as well as responsibility.

• **Persons in charge of research** and development programs should be given packaged resources—funds, facilities and personnel—more often. At present, control over these three elements are usually split.

• **Office of the Deputy Chief of Staff,** Development, should concentrate its efforts along the important staff lines of research and development requirements, policies, resources, program integration and program evaluation. These tasks can be accomplished in such a way that the total number of staff personnel is reduced and detailed direction of the Air Research and Development Command is eliminated.

• **Air Research and** Development Command should be reorganized along the distinct functional lines of the research and development program, i.e., research, technical development, weapons systems and testing. There should be deputy commanders . . . in charge of each of these areas who, not only have the responsibility for the program but are also in charge of the centers, laboratories and other facilities which are directly engaged in their activity.

"An objective of this reorganization is to consolidate and reduce the staff and overhead personnel of the headquarters, Air Research and Development Command, and its centers. This change should be accomplished in a way that the detailed research and development program carried out is directly at the working level in the centers, and the laboratories."

• **Weapon system concept should** be reviewed and revised because . . . "in some respects it has been carried too far. In theory it is desirable, but a practical means must be found for taking advantage of its inherent capabilities.

• **"Those portions of the research and** development budget used for research, state-of-the-art development and the development of radically new weapons should be substantially and immediately increased."

• **Air Materiel Command** should not be the sole procuring agency for the Air Force, and Air Research and Development Command should be designated as a procuring agency.

Four Broad Concepts

Four broad concepts are cited by the committee as being the foundation of their recommendations. They are:

• **"There is a growing lack of trust** in the capability and performance of individuals at the working level in research and development, not only in the Air Force but throughout the government. This growing lack of trust has resulted in taking away from the working level the authority, but not the responsibility, for research and development projects, and diffusing this authority in a host of organizations and individuals in higher echelons; it has resulted in an increase in staff work of all sorts on matters of minutia; it has resulted in increasingly detailed technical direction from higher policies and planning echelons to lower working level echelons in the research and development organization; it has resulted in an increase in the constraint on the use of money, people, facilities and on the resources required at the working level to do the research and development job. The lack of trust is extended into the contractual relations with industry, academic and other private organizations.

• **"Unless trust is restored** and these symptoms of distrust eliminated the Air Force can never hope to reduce the length of its development cycle to that required to maintain technical superiority in weapons over our potential enemy.

• **"Many changes needed** to improve management and conduct of research and development in the Air Force depend upon other governmental agencies, such as the Department of Defense, the Bureau of the Budget, the Congress, and executive office of the President."

• **Technology will continue to affect** the Air Force at a growing rate and . . . "the research and development phases will enlarge and become of greater importance. Though in the past the Air Force has introduced major changes to adjust to this increasing role of research and development, it has not yet kept pace with the need.

• **"In order to handle its increasing** technological problems, the Air Force will need a higher percentage of better trained, more capable technical personnel—officers, civilians and men."

In its introduction, the Stever report reviewed some of the history of Air Force research and development and praised the action in 1950 which established the post of Deputy Chief of Staff, Development, and the Air Research and Development Command. It said one of its most lasting benefits was accrued because "representatives of the R&D organization were brought for the first time into the highest policy-making and planning channels of the USAF."

The report points out that, due primarily to the Korean war, budgetary improvements were made in the general research and development picture in the U.S. and that the Air Force was able to realize impressive gains from the added funds because of the reorganization of its research and development capabilities and its greater use of university and industry contract groups.

Toward the end of the Korean war, the level of financial support for research and development was greatly reduced and U.S. national policy altered in an effort to reduce the cost of the military establishment by placing reliance upon few weapons of better quality and destructive power. The committee said the result was that funds were cut to a point where development of the modern weapon was seriously crippled.

Major Fault

The report said another major fault of the economy program was the greatly increased interest in the military economy brought about stricter administrative controls, particularly in R&D. Project direction was carried to much higher administrative levels than before. Decision-making became more ponderous as did procedures for providing the resources—people, dollars and facilities—required to get the R&D job done.

"These two general factors, limited budgets and excessive administrative controls, together with some evident reservations within the Air Force about either the capability of the R&D organizations, or the importance of R&D, have partially vitiated the early accomplishments of the new R&D organization within the USAF."

The committee also attacked rivalry

gines installed in lateral pack on underside of wing each will furnish approximately 25,000 lb. of thrust without afterburner. Although tailpipes are larger than inlets, the engine package has constant depth from front to rear.

• **Missiles would be accommodated** in a recess under the engine pack, will include guide bombing type or self-guided air-to-surface type. Countermissiles may also be carried. Undoubtedly, special weapon design will be required to cope with B-70 and F-108 operational conditions. Missile warheads would have to be designed to resist high heat generated by Mach 3 speed. Some missiles may require propulsion systems which will ensure sufficient acceleration at launch to pull away from plane traveling at Mach 3. Techniques will have to be refined to ensure proper separation of missile from aircraft.

• **Lightweight, rigid construction** will incorporate about 10,000 sq. ft. of sandwich panels. This will be substantially in excess of the amount of sandwich ever used in any aircraft previously. Convair's B-58, a big user of honeycomb construction, uses 282 stainless steel honeycomb sandwich panels, totaling 1,082 sq. ft.

Extensive Planning

Against a backdrop of far-reaching technological progress in the last few years the WS-110A probably represents the most thoroughly planned manned or unmanned weapon system ever scheduled for the Air Force arsenal. This thoroughness can be attributed to the Air Force's three-pronged attack on complex problem of development, procurement and operation of an extremely flexible, lethal weapon combining advantages of human capability and top mechanical reliability, coupled with sustained high supersonic potential.

Need for the WS-110A bomber system was based on a searching military analysis which probed future potential to determine when B-47 and B-52 bomber concepts would be obsolescent, even with improvements which had been projected for these weapons. Air Force determined how far these strategic systems could be stretched and from the projected date established the time schedule for introduction into the operational fold of a heavy long-range Mach 3 bomber. This led to the competition between North American Aviation and Boeing Airplane Co., with the requirement to provide the most feasible technical advances for the most modern bombing system. After proposals and study contracts, North American Aviation won the competition, was awarded Phase I contract late last year.

Traditionally, Air Research and Development Command and Air Materiel Command have been selecting agencies for Air Force weapons. WS-110A project represents the first time that Strategic Air Command, the operational agency, has been painstakingly associated with all the ramifications of the program from the very inception. All three commands are familiar with every technical requirement. Every refinement—even to the extent of fuel gage relocation on the mockup—is closely scrutinized as a result of close liaison between North American Aviation, weapon system manager, and SAC, whose core of experts has combed operational records of B-52 and B-47 to design preventive factors so that the B-70 will have a minimum of downtime.

Close scrutiny afforded the entire program by Air Research and Development Command, Air Materiel Command, SAC and North American is aimed at removing almost completely the elements of chance in development of the over-all weapon system. Experts close to the WS-110A activity feel that a minimum gamble is involved in the project. No new inventions are required for its success.

Maximum use has been made of equipment already in existence, wherever this use is feasible. Strategic Air Command's complete inventory of existing equipment has been surveyed in a study extending over a year, ensuring that every possibility for utilization in the WS-110A system was evaluated. This has comprised a big effort, saving substantial sums of money.

Phase I contract, now under way at North American, includes all planning up to operational capability. Major activity is readying of mockup, formulation of specifications and selection of major subcontractors for B-70 subsystems. About 15 subsystems will be subcontracted during Phase I for feeding into Phase II flight articles.

Mockup will be completely comprehensive and will include simulation of a weapon system comprising the B-70 bomber and support equipment in such detail that even kits which mechanics will require will be simulated.

Phase I will end when the Air Force Mockup Board completes its examination of the weapon system mockup. Phase II contract, which will be awarded to North American before completion of Phase I, will include production design, tooling and manufacture of a prototype and other flight test articles. At the end of contract Phase II, probably eight B-70 bombers will have been fed into the flight test program. These should comprise a substantial pool of aircraft with real operational capability, complete with ground support equipment and trained flight and ground crews.

Although the B-70 will be a complicated embodiment of automatic equipment probably warranting its description as a huge flying computer, the design will make maximum use of a flying crew for flexibility and last minute decision. This means that efforts have been stretched to make sure that crew members will be both comfortable and safe. Design goal has been to make it as easy for the crewman to operate as if he were sitting at a desk.

Crew Protection

Methods have been devised for protecting crew members from high temperatures. Problems of noise and vibration stemming mainly from aerodynamic effects will be no high hurdle. Decompression and emergency escape difficulties will be minimized.

Provision has been made to continue a mission even though substantial damage has been inflicted on crew quarters. Additional internal provisions have been incorporated to permit the crewmen to continue his function even if primary protection is impaired.

For actual bailout, it is certain that no conventional ejection seat will be included. For protection against Mach 3 blast and to provide oxygen in high altitude bailout, an encapsulated-type seat with flotation capability would be used. The capsule scheme also would be in keeping with the Air Force's philosophy of stressing terminal environment protection.

These provisions for man's safety and comfort will involve weight and cost penalties, but these factors have been kept as low as possible, considering the detail and complexity of equipment problems in a high performance configuration.

The F-108 long-range interceptor and the B-70 embody similar design considerations. The F-108 configuration also is similar to the B-70's, except that on the F-108 the canard control surfaces are located midway on the fuselage forward of the crew compartment and the engine intakes are on the fuselage side, feeding the turbojets in the aft fuselage section. Design points of the F-108 include:

• **Mach 3** cruise speed.
• **Cruise altitude** of about 70,000 ft.
• **Range,** approximately 1,100 mi.
• **Gross weight** of 100,000 lb.
• **Crew of two**—pilot and weaponeer. Each will have own downward-ejection escape capsule, which probably will be similar in over-all aspects to scheme of that in B-70.
• **Weapons will be** three Hughes GAR-9 atomic-warhead Falcon missiles carried in a weapon bay.
• **Power plant package** will include two General Electric J93s.
• **Fuselage will be** approximately 80 ft. long, wing span about 58 ft., and 22 ft. to top of double vertical tail.

(This is the first of two articles on Mach 3 aircraft. The Second will appear in next week's issue.)

derstands, for example, that approximately 80% of the funds employed in the research and development activities in the Air Force are not under the direct control of (Deputy Chief of Staff, Development) or ARDC but come from procurement, construction and military personnel appropriations."

The Air Materiel Command is responsible for preparing Air Force budget requests and is the only procuring agency in the Air Force.

Regarding this, the committee noted that Air Materiel Command prepares, . . . "budgetary information concerning by far the largest portion of the R&D operating budget after having exerted an important influence on the character and size of the items going into this portion of the budget. . . . ARDC may contract only on the basis of delegated authority from AMC and is subject to its review and control of important contracts and contract terms and procedures. . . . Present budget categories do not provide sufficient flexibility to accommodate rapidly changing science and technology of air warfare.

"Nor do they fit the need for a firmer foundation of stability and continuity of funds for most basic research and certain technical developments."

The committee recommends that R&D managers "should be held responsible for total costs in major areas of performance in terms of results produced, not told in detail how their dollars should be spent."

It also recommended that research and development funds be consolidated under ARDC control and that many types of development contracts which have long been in use and for which accurate cost and time estimates can be made should be kept separate from the research and development funds.

Another major suggestion was that "ARDC should have major Air Force responsibility and authority for determining the terms and condition (of contracts) . . . and that ARDC should be made a procuring activity with all of the authority commensurate with such a status."

The committee said that increased emphasis on research and development "should be reflected in more favorable arrangement with R&D contractors." The law permits a contractor to receive a fee of up to 15% of the cost of a research contract, but the committee said that in practice this figure is closer to 7%. It added:

"Formulas for computing overhead for both profit and non-profit contracts are so strict that contractors must regularly absorb costs that are really essential to getting their R&D done."

The report also recommended that "the Air Force . . . (allow) fees more nearly up to the levels now permitted by law."

Italy Wins Aerobatic Competition In Netherlands' Military Air Show

By David A. Anderton

Soesterberg, Netherlands—Italy's crack 6th Air Brigade Red Devils team flew off with first prize in an acrobatic competition held as part of a NATO airshow here. Host for the show was the Royal Netherlands Air Force celebrating its 45th anniversary. The entire show was military with all NATO air forces participating and NATO air chiefs attending.

USAF made the biggest showing with operational units, the Skyblazers acrobatic team, a refueling flyby, a Boeing B-52 flypast on a round trip from the United States and flight demonstrations by the Lockheed F-104 Starfighter and McDonnell F-101 Voodoo. Six teams from Belgium, Greece, Italy, the Netherlands, Portugal and Turkey entered the acrobatic competition.

USAF and RAF teams were not entered because they are regarded as professionals. First eliminations left three finalists: Belgian group under Maj. Bladt flying Hawker Hunters; Italian Red Devils under Maj. Mario Squarcina flying Republic F-84F Thunderstreaks; Netherlands team under Capt. N. H. Themen also flying Thunderstreaks.

Finals were actually held July 3 which was just as well because low ceilings estimated under 800 ft. plus ground haze on the formal show day made acrobatic routines almost impossible. The Greek team, demonstrating in a pre-show exhibition, lost the field completely during the routine and could occasionally be glimpsed performing magnificently several miles from the field.

Show was excellently planned with three separate sections given during the day. About a quarter-million spectators were on the field when the main display began with French Caudron G3 bomber of World War I flying low over the field while an Avro Lincoln and two Vickers Supermarine Spitfires of RAF's golden age flew a formation pass above the ancient craft.

Gloster Meteor 8s used by the Dutch as target tows flew past in trail towing flags of NATO countries, and the show was on. It was a flying show all the way.

USAF Skyblazers and RAF Squadron 111 shared honors for top performance, giving their usual impeccable routines new verve with much added smoke. At least twice the Skyblazers covered the field so thickly it was difficult to see the planes on the next pass.

Weather made the Italian team look worse than it had been. Tightness of formation suffered and although the initial part of the routine with six men went off hitchless, the second part, using five-man formations, was sloppier. Netherlands team, also flying Thunderstreaks—which both groups admit privately is not the ideal airplane for acrobatics—held formation well laterally, but vertical separation was quite variable during flight. Holding on runway intersections, used as targets for the center of routines by all teams, was not as good as other outlifts. Observers were impressed by Belgian team flying Hawker Hunters. They held good formation and flew somewhat slower than other teams in a lazy sweeping style reminiscent of performance of last year's Italian team from the 4th Air Brigade. The Belgians were a little wide on formation changes but performed in general one level above the rest. For windup, they roared across the field in a shallow V toward the official grandstand trailing red smoke and broke right and left out of formation into an opening fan.

Other main points:

• **Lockheed C-130** demonstrating short field landing, backing into position, offloading 85 Belgian infantrymen with equipment and making a maximum performance takeoff from the middle of the runway. In contrast, the performance of a Blackburn Beverley from RAF Transport Command which demonstrated unloading of the Bristol Bloodhound anti-aircraft missile left much to be desired. The Beverley was met on ground by a light vehicle towing a missile transporter and the missile was manhandled out of the cargo plane onto the transporter by straining technicians.

• **Simulated weapons demonstration** by 12 Netherlands Air Force Thunderstreaks. First wave knocked out the target completely with inert napalm containers and the second wave, after slowly orbiting the target twice, had to pull out without firing. Third wave made rooftop run-ins in pairs with the left-hand man only dropping tanks in the target area.

• **One of 12** North American F-100 Supersabres had the starboard wingtank shackle let go partially during takeoff run, got off the ground with the rear end of the tank oscillating wildly. After clearing the area pilot was replaced in formation by a 13th Supersabre which took off about two minutes after the formation. Pilot of the aborted flight dropped tanks, returned to the field and in landing deployed a drag chute which promptly ripped off. He finished his landing roll at the far end of the runway.

between the services by declaring that:

"There has been an intense research and development rivalry as each of the services has worked hard to establish its future in the air defense, guided missile and space fields. . . . This competitive process (has not been limited to) . . . that essential to most rapid progress. As a result, the roles and missions of the services have become competitive rather than complimentary.

"This situation has imposed an additional burden on top of the already heavy cost of modern weapons. Because of it, budget agencies outside the R&D management structure have sought to reduce costs by themselves intruding into the detailed R&D phases of management. From the point of view of the USAF, the situation has been further aggravated by a lack of understanding of sciences related to airpower at levels of government above the Air Force.

"We have just gone through another national awakening to the importance of science and technology. In its aftermath, the President has taken two steps of major importance: first, he has presented a reorganization plan for the Department of Defense, including the establishment of the Advanced Research Projects Agency; second, he has appointed a Special Assistant for Science and Technology and revitalized the President's Science Advisory Committee. It is hoped that these steps will lead promptly to major improvements in military R&D management and that the appointment of a number of officials throughout the decision-making structure of the government who understand the dominant technologies of our time will come about. As the needed improvements in R&D management are studied by the higher echelons of the government, the USAF has a major responsibility to make known its problems, needs and recommendations."

Needed Philosophy

In its rundown of the philosophy required of top officials, the Stever Committee said "Over the long term, it will be far cheaper to risk the occasional failure of a project than to have excessive (control) . . . encumbering the program and lengthening radically the development cycle. . . .

"Those who argue that the checks and balances of a democratic government require the kind of detailed controls we have now in military R&D must come to realize that either the authority for decisions must be delegated within over-all policy guidance or we will lose the struggle for technological superiority. . . . Higher level controls cannot substitute for competence at the level when the job should be done."

The group underscored . . . "its belief that the needed reforms must begin at the very top in the legislative and executive branches of the government, as well as within the Air Force itself."

In its discussion of the weapon system concept, the committee said it felt that too much emphasis has been placed on the systems aspect to the detriment of the development of superior components which, it said, in the end govern success of the system.

Example Problems

Using the ballistic missile program as an example of the problems to be faced by the Air Force when it has major weapon systems employing new and unfamiliar technology, the committee said USAF was wise ". . . to contract for outside technical assistance in the management of this program.

"The committee believes that the Air Force program in this field is at its present advanced stage largely because of the unique competence of the Ballistic Missile Division-Ramo-Wooldridge-AMC-SAC was combined with the authority to package the facilities and resources.

"The committee has not undertaken to investigate the current implications of the arrangement with the Ramo-Wooldridge Corp. to the extent that is required, but it is obvious that some problems have arisen. Time appears to be on the side of a satisfactory solution, for the reliance of the Air Force will change in character.

"As the Air Force and a large number of its contractors gain experience and competence in the ballistic missile field, the need for outside assistance in the technical management will be greatly reduced. The Air Force should relax detailed management as the contractors prove to be more capable of handling details."

The committee also made recommendation for a new breakdown of the types of weapon systems for better management. It said:

"The weapon systems divide themselves naturally into two major categories: flying vehicle systems and ground environmental (i.e. air defense) systems." At present, the ARDC . . . "separates the management responsibility for flying vehicles into ballistic and aerodynamic systems. This separation arose because of the high urgency of the ballistic missile program and the decision to contract for its technical management."

To prevent future confusion as the differences between aerodynamic and ballistic systems becomes less pronounced "the committee recommends that a vice commander (ARDC) be placed in charge of all aerodynamic and ballistic systems and under this vice commander there be a deputy commander for aerodynamic weapon systems and a deputy commander for ballistic weapon systems. Obviously the missions and authority eventually assigned to the Advanced Research Projects Agency and the National Aeronautics and Space Agency will bear directly upon the decisions as to which types of weapon systems will be managed in these different organizations, but we presuppose that the Air Force will continue to have R&D responsibilities in both areas."

The Stever Committee was especially critical of the small amount of money being spent for research, state-of-the-art development and the development of weapons of entirely new concepts. This policy, it said, is in direct opposition to the recommendations of the Scientific Advisory Board's Ridenour Report of eight years ago. The Ridenour report said steady advances in the technology of air warfare would require steady increases in the relative expenditures for R&D.

This was not done, and the Stever Report criticized the policy of reporting the overhead costs of installations, such as Wright Field and the missile test centers, in the research and development budget and creating the impression that the pace of research and development effort was increasing.

R&D Budget

The report says that during the 1946-1950 period, the USAF research and development budget was held at an inadequate level of about $200 million per year and all attempts to raise it failed. It says: "It was claimed that there were not enough technically trained people to spend more for this basic R&D; at the same time, competent technical staffs in industry were in the need of work, and the U.S. Bureau of Labor Statistics was urging young people not to go into technical schools because there was a glut of engineers.

"With the Korean War, the R&D budget rose sharply for about three years and funds available for the actual development contracts with industry remained about 70% of the over-all R&D budget." This situation, the committee said, has since deteriorated and now, "during the first year of the Sputnik, the over-all R&D budget has declined, and the funds available for contracts with industry have dropped sharply to under 50% of the total. . . . At the same time, the Soviet technological threat has been recognized and extensive programs are being discussed in the U. S. to train more scientists and engineers. We are cutting down on the demand for technical people while simultaneously trying to increase the supply of such people."

In regard to financial procedures and requests for funds, "the committee un-

off by an actual submarine. "Submarines," Thach explains, "are so expensive that everyone who needs ASW training can't have a real live target. A simulator could provide the answer."

• **Better sonobuoys.** Thach believes that "the field of sonobuoys has hardly been scratched. We need something we can put into the water and then recover it, plus others that are so inexpensive there would be no need to recover them. There's great room for improvement to provide sonobuoys with delicate listening and active (transmission of sound waves) capability."

• **Automatic tactical navigation** equipment for ASW search aircraft. Adm. Thach, who on occasion flies an S2F on search missions, wants improved automatic navigation equipment, possibly incorporating a memory system. He explains: "As it is now, you get out on a search, probably getting sidetracked from your original destination on the way, go back and forth, and then wheel around the 'datum' in tight turns. In marginal weather, the pilot often loses his fix, and then everything is against him."

• **Psychology.** Adm. Thach sees a wide range of needs for advice from competent psychologists. He would like a study, for example, of the habitability of aircraft as an aid in determining how long their crew members can remain at peak effectiveness. He would like psychologists to take a look at how a sonar operator works. "Sometimes," he says, "an operator loses his contact at a critical time when maybe he shouldn't. Possibly a psychologist could tell us what's wrong. Maybe we've been doing something wrong with him that we could change.

"Right now a sonar operator in a (Sikorsky) HSS-1 helicopter can work only about 15 min. at a time because of all the noise. We'd like to know how we could extend this time.

Lack of Funds

These are some of Adm. Thach's needs. They are there primarily because of the lack of funds normally approved for this area by the Budget Bureau and, to a lesser degree, Navy's reluctance in the past to openly acknowledge that it had serious problems.

One top official, not Adm. Thach, also complains that "even in the Navy there's too little recognition of the overall ASW problem. Destroyer people think only in terms of destroyers, submarine people of submarines. Aviation people often don't think about ASW at all."

In an effort to partially overcome the money problem, Adm. Thach hopes to arouse industry interest to the point where firms will accept "one-dollar contracts" which would give them a "need to know" and make available classified information. Out of such contracts, he believes, will come answers to many of his problems as well as hardware contracts for the companies involved.

The Admiral, with Navy's blessing, is actively encouraging industry to send their representatives to sea with ALFA to get a first hand look at its equipment problems. On its first operation in April, there were approximately 30 industry scientists and engineers aboard the Valley Forge. Since then, there has been an average of six industry or research center representatives at sea with the task force each week.

Industry Interest

Airframe manufacturers who have sent their representatives aboard include Douglas, Grumman, Lockheed, North American and United Aircraft.

From the airframe companies, Adm. Thach expects more than proposals for new fixed-wing and rotary aircraft. He believes, for example, that their experience could lead to the design of hydroskis for small search ships.

Still another area in which Adm. Thach needs help is in the field of oceanography. Top Navy officials in the Pentagon who are concerned with antisubmarine warfare as well as their colleagues assigned to Task Force ALFA agree that the submarine can never be fully conquered until the U.S. has far greater knowledge of the ocean and of its inhibiting effects on ASW detection and classification gear.

When, and if, all the answers are in, sonar probably will disappear as the principal means for anti-submarine detection, possibly being replaced by some form of magnetic or electromagnetic detection system. But, in the meantime, Adm. Thach believes present sonar systems could be vastly improved if enough Navy and industry effort were put to the task.

Fire Control Study

New technique for airborne fire control systems employing passive detection and ranging will be studied for Wright Air Development Center by the Guided Missile Division of Fairchild Engine and Airplane Corp. under a $300,000 contract awarded last week. System is called Pacor and based upon principles used in the company's Padar (Passive Detection and Ranging) system which obtains information on location of enemy aircraft though reception of its radar signals, determining azimuth and elevation directly and range data by measuring time of arrival between direct signal and signal reflected from the ground.

Jupiter Radiation Photographed Measured During Recovery Test

Radiation from a Jupiter intermediate range ballistic missile during reentry was observed and successfully measured last May in a test program called Operation Gaslight, conducted as part of the first recovery test of a full-scale Jupiter nose cone, the Army announced last week.

Project employed photographic, radiometric and spectrographic techniques to study the missile re-entry over a spectrum extending from the ozone cutoff point of near ultraviolet, through the visible spectrum, to the 2.7 micron region of near infrared.

Operation was under the direction of the Research Projects Laboratory, Army Ballistic Missile Agency, with the assistance of Barnes Engineering Co., Avco Research Laboratory, Aerojet-General Corp., and Thermal Radiation Laboratory, Air Force Cambridge Research Center.

Missile Trajectory

Missile was launched from the Patrick AFB firing range at Cape Canaveral, Fla., at 1:06 a.m. on the morning of May 18. Flight distance was approximately 1,500 mi. and flight time about 15 min. Two ships stationed in the target area northeast of the island of Antigua tracked the missile as it reentered the atmosphere at a speed of about 9,000 mph.

Nose cone was recovered successfully at the impact point by a Navy recovery fleet.

Visible Radiation

Calculations indicated that the altitude where visible radiation would begin to be emitted was about 200,000 ft. Missile appeared near the expected reentry point with a visibility at first about as bright as a third magnitude star. Within three seconds after its appearance, the spot of light had separated into three objects.

The brightest light resembled a huge magnesium flare and was assumed to be the missile's booster. Light emitted by this object definitely pulsated. Its trajectory carried it closely in line with the planet Jupiter at one point, where it was estimated to be about 1,000 times brighter than the planet.

Second brightest visible object was assumed to be the instrument compartment. The actual trajectory of this

Navy Asks Industry Aid in ASW Battle

By Cecil Brownlow

With Task Force ALFA—Navy is seeking urgent help from industry in a money-short effort to develop reliable equipment that will find, track and destroy an enemy submarine with reasonable assurance of success.

Navy's push and its willingness to finally openly admit that it has a serious problem were born from knowledge that missile-bearing submarines are beginning to slide down Soviet ways and the even surer knowledge that the U.S. has no reliable means of stopping them in time of war.

ASW Task Force

The missile submarine—of which Russia probably now has three or four equipped with air-breathing weapons roughly comparable to the 500-mi.-range Regulus I—also was responsible for the formation of Task Force ALFA. This semi-permanent anti-submarine task force was ordered into existence last fall by Chief of Naval Operations Adm. Arleigh A. Burke. It first put to sea in April.

Fighting a grim, often monotonous battle off the U.S. Atlantic coast, ALFA is attempting to train men and devise tactics to a point where the combination will at least partially offset the unreliability of available equipment.

Its commander, Rear Adm. John S. Thach, also hopes to come up with new and firm proposals as to just what types of equipment are needed and, in turn, to encourage industry and research centers to provide recommendations of their own.

The greatest anti-submarine problems facing ALFA, and the Navy as a whole, are those of detection and classification. "If I can find him and identify him," Adm. Thach says, "I can kill him."

To "find him," Adm. Thach believes he will need across-the-board help from almost every segment of U.S. industry.

He needs better electronic gear that can detect and classify a submarine over wide areas regardless of the varying temperature gradients of the water; aircraft and helicopters with greater lift capability and longer endurance; better means of communications between the various components of the task force; more accurate visual displays; a better knowledge of the ocean itself; better training devices, and even the experience of trained psychologists.

The snorkel submarine already presents too great a problem for the equipment on hand—and this includes the latest sonar devices now reaching the fleet or being installed close to the U.S. shoreline. Impact of the fast, deep running nuclear submarine that can remain submerged indefinitely and fire ballistic missiles from 1,500 mi. at sea will multiply its seriousness and the effort both Navy and industry may be called upon to expend. Right now, Adm. Thach says:

"The black boxes are not good enough, and they're not coming fast enough to keep up with the advances of the nuclear submarine."

An official brochure outlining Navy's anti-submarine warfare problem in general terms notes that, "Ideally, each anti-submarine vehicle should have integral ability to detect, classify, track and destroy every contact gained." It further notes:

"Such a capability is not in sight."

All means of underwater detection used thus far—sound, electromagnetic, electrical and magnetic—are limited in range and capability. Sonar, the mainstay of present ASW equipment, is unreliable at best. Used actively, its sound waves searching for a submarine hull can be deflected, bent and distorted as they strike against layers of water with varying temperatures. Employed passively—where it only "listens," hoping to detect the screws or household noises of a submarine—it picks up and relays to the sonar operator all the noises of the sea, and they are multitudinous.

Foreign Noises

Particularly in the early evening, the receiving unit of a listening sonar literally bristles with foreign noises that can mask those of a submarine. Coming in loud and clear are the low-throated hoots of whales, shrill cries of porpoisees, crackling snaps from the feelers of schools of shrimp and the thumping beat of dogfish that, to the untrained ear, sound remarkably like energy pulses from a submarine.

Active sonar also makes little or no distinction between a submarine and a whale or schools of smaller fish. Magnetic aerial detection gear carried by Grumman S2F search planes flying from ALFA's flag ship, the Essex-class carrier USS Valley Forge, is unaffected by the water temperature and can at least determine whether the contact is metallic. Its fault lies in range, which is severely limited.

To overcome these restrictions, Adm. Thach is ready to receive recommendations on and test any principle or phenomena presented by industry or research centers which bear hope of success. Areas he would like to have explored by private industry include:

• **Range.** Appreciably better range for both sonar and MAD gear is needed now. The problem will be magnified when the Soviets send nuclear, missile-bearing submarines into the Atlantic and Pacific. As an example of the vastness of the ASW problem, the North Atlantic, which could hide a number of submarines, has 12 million sq. mi. of ocean surface.

• **Maintainability.** Electronic equipment that can be easily maintained and repaired is vitally needed.

• **Sound frequency study.** Thach would like to see a thorough study made of the sound frequency spectrum, from ultra high to extremely low, to see if the means and range of detection can be improved through adoption of frequencies not now employed. Navy is sponsoring some research in this field, but Adm. Thach says much more is needed.

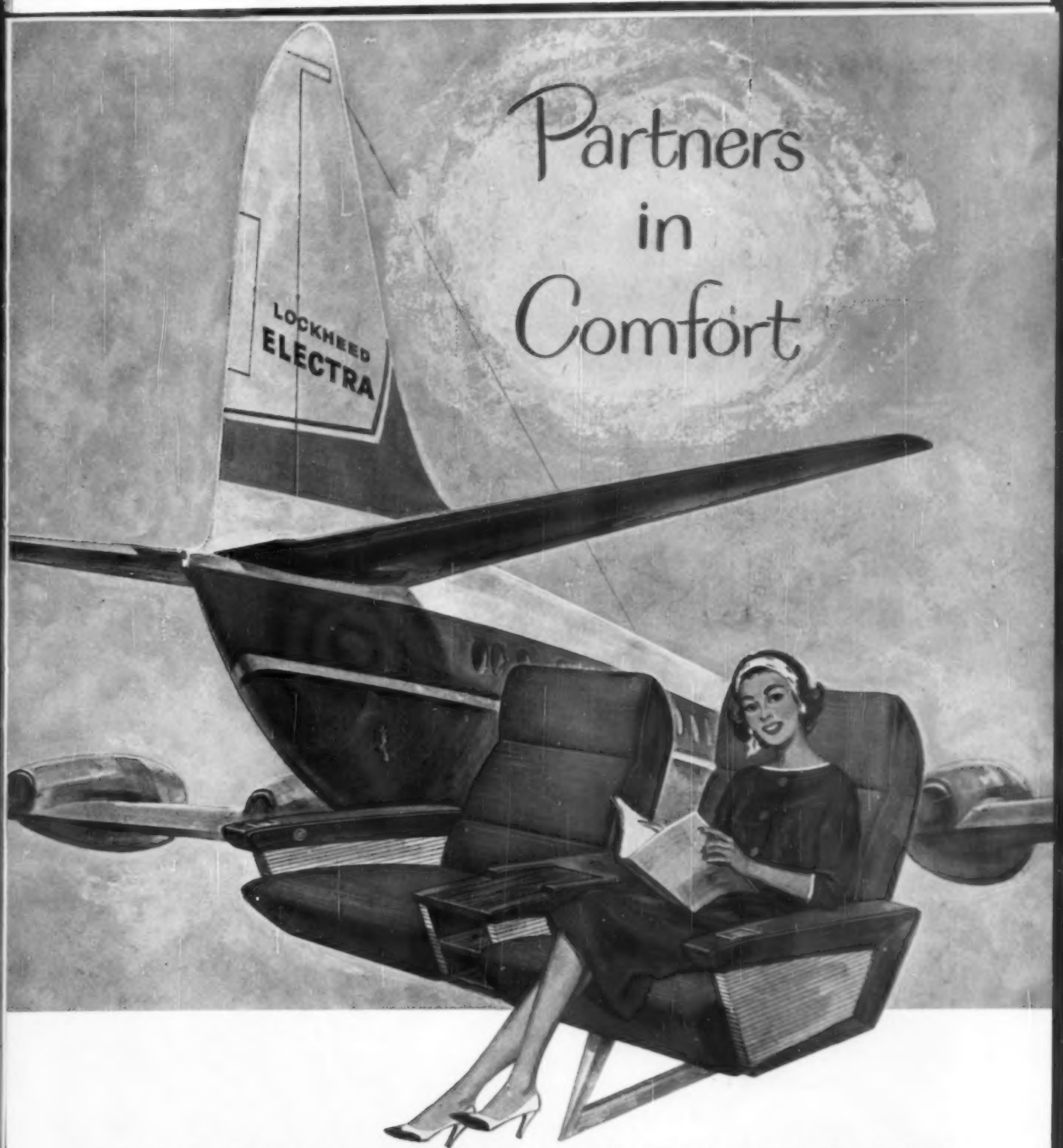
• **Communications.** Better means of communications between the various elements of an anti-submarine task force—particularly between a surface ship or aircraft and a submerged hunter submarine—are needed. ALFA already has made specific proposals to the Navy and industry in this area from information gained during its three months of operation. Another need highlighted by ALFA's experience is for better methods of channeling information that has been communicated from a search vehicle with a contact to Adm. Thach, who must make the final decision as to what action to take.

• **Automatic data display.** Adm. Thach's flag plot of the tactical situation in training exercises is relatively crude and hand drawn. Unless a better method is soon found for instantaneous display of the situation, giving the relative position of task force units and that of a "datum" (an "enemy" submarine), Thach believes the Navy may eventually go to closed television circuits. "I want," he says, "a picture of everything moving and information that people on the spot have that I need to know."

• **Synthetic trainers,** both to instruct commanders on the best means of employing aircraft, surface vessels and hunter submarines working as a team in search and kill operations and to teach pilots, sonar operators, etc., how to efficiently handle their equipment. Navy already has some trainers in this field, particularly at the ASW Tactical School in Norfolk, but more refined systems are needed.

Submarine Simulator

In a related area, Adm. Thach also would like to see the development of a simple electronic system that could simulate a submarine—one that could move, at least synthetically, and transmit a strong echo similar to that given



There's excitement in the air as America approaches the jet age of travel. Anticipation runs high as air travelers look forward to new concepts of flight. Lockheed's Electra prop-jet, for example, will slash time schedules with its smooth, dependable, vibrationless flight. The Electra's wider cabin means more passenger comfort. Hardman has worked with Lockheed to give you this comfort. Spacious Hardman lounge divans will provide gracious elegance. The Electra seats being produced for Hardman airline clients offer "magic carpet" passenger luxury in the new air age.

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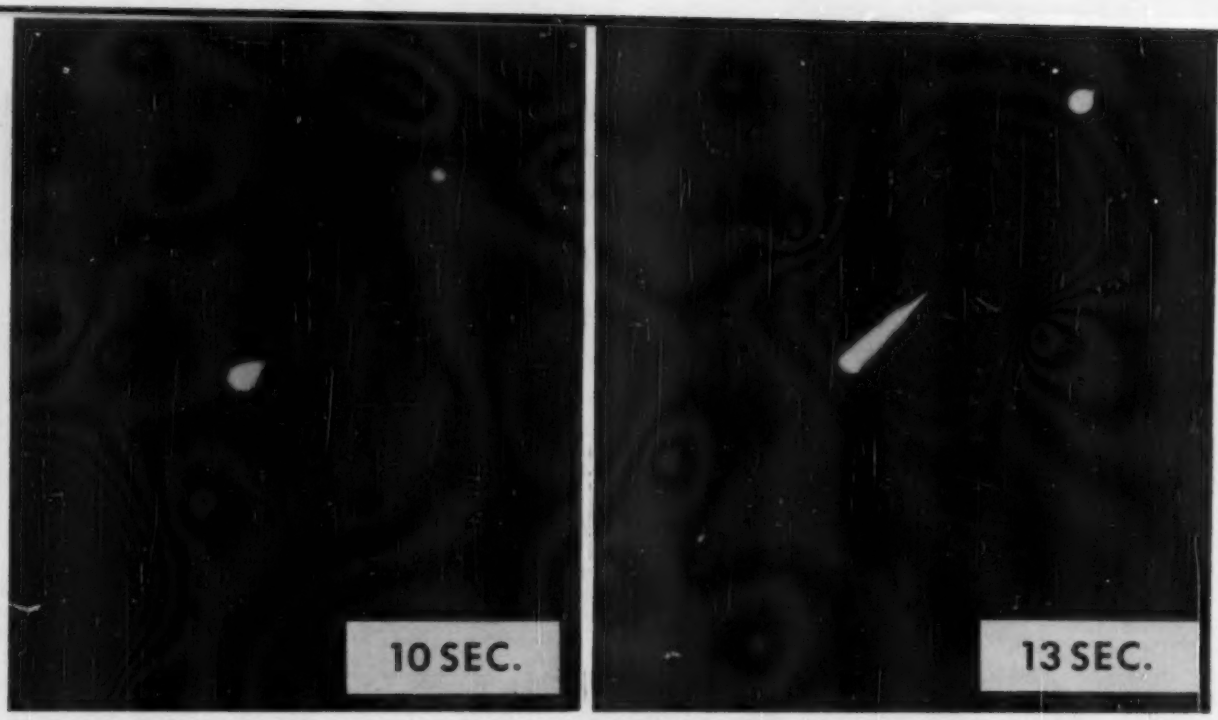

PICTURE SEQUENCE of Jupiter re-entry, timed from moment of first visual sighting, shows rocket casing (center) and instrument package begin to glow at 10 sec. At 13 sec. (right), the nose cone appeared as a small speck ahead of the rocket case.

object during its re-entry burning period was much shorter than either the booster or the nose cone.

Third object, the nose cone, appeared just ahead of the booster and continued to move rapidly ahead. During the last few seconds of visible flight, the booster and nose cone moved behind a large cumulus cloud where the radiation was sufficiently intense so that the whole cloud was illuminated. It was during this part of the flight that the booster ceased to glow and became invisible.

Nose cone was seen to appear from behind the cloud and was tracked for a few more seconds before it cooled enough to become invisible. The total time of visibility was approximately 24 sec.

Radiation from the missile during re-entry was sufficiently intense to perceptibly illuminate one of the test ships more than 50 mi. away. Additionally, some of the measuring instruments in each part of the spectrum were saturated, indicating that the radiation level may have been higher than anticipated.

Army indicates that considerable usable data appears to have been obtained. Instability of the test ships due to a mild swell resulted in a complicated re-tracing of portions of the spectra obtained by some of the cameras.

Instrumentation of the operation was aboard a Navy radar destroyer, the USS Stickell, and one of the firing range

AT 15 SEC. the instrument package (upper right corner) is breaking up and the pulsating radiation pattern from the rocket casing is evident. In final shot, instrument package has vanished. Nose cone is still visible at lower left of photo.

telemetry ships, the M. V. Sword Knot. The instruments used included:

• **Barnes Engineering Co.** Instruments supplied were a cluster of six F-8 aerial reconnaissance cameras modified for use as spectral meteor cameras with transmission replica gratings of 300 lines/mm., a four-inch-wide field radiometer with a lead sulphide detector and end-on photomultiplier photometer, a 35 mm. motion picture strip camera equipped with a grating and a second camera from which flight directions and time sequence were recorded.

• **Avco Research Laboratory.** Avco supplied two photomultiplier radiometers (two channel and six channel) equipped with interference filters to isolate narrow regions of the spectrum. These were used to measure predicted gas emission bands and the temperature of the re-entry bodies. Spectra was also recorded for 17 sec. by a 16 mm. cine-spectrometer while a second camera obtained color pictures for 12 sec.

• **Aerojet-General Corp.** Personal operated their M28 portable radiometer, equipped with a lead sulphide detector, which was boresighted with a tracking telescope and a 16 mm. motion picture camera. A WWV reference timing signal was registered on the radiometer record. Clouds limited the recording of data to about 10 sec.

• **Air Force Cambridge Research** Center. Personnel from the center operated two photomultiplier radiometers mounted and collimated on a gyrostabilized Mk.51 gun director, plus a 4x5 in. Speed Graphic camera equipped with a 150 line/mm. transmission grating. Two additional cameras, Type N-9 GSAP, were boresighted with the radiometers on the gun director, one equipped with a specific transmission grating.

IAS Proposes Press Coverage

Los Angeles—Proposals that the Institute of The Aeronautical Sciences drop any attempts to provide even minimum facilities for daily press and magazine coverage of its technical sessions were voiced by the IAS professional staff at the Institute's annual summer meeting here last week.

A staff spokesman for IAS told reporters attempting to cover the session that "the IAS council couldn't care less if it didn't get any of this publicity."

Few preprints of technical papers presented at the meeting were available for press use; nor were there any press facilities provided at first for coverage of luncheon and dinner speeches.

Several Los Angeles newspapermen walked out of the technical sessions when it was evident that no copies were to be available of papers presented. Later IAS made provisions for a press table at luncheon and dinner speeches. But the Los Angeles press corps refused to accept the Institute staff's sudden hospitality and covered the speech of Asst. USAF Secretary Richard Horner from other positions in the room.

Two prominent aviation writers for Los Angeles papers, Marvin Miles of The Times and Tow Towers of The Examiner, told AVIATION WEEK they planned to write public criticism of the IAS press policy in their newspaper columns.

When queried by AVIATION WEEK on the IAS policy statement made by the professional staff member, S. Paul Johnston, director of the Institute, said:

"This was overstating the case. Whatever press policy has been made I have made it. In principle we are not seeking press publicity or any publicity at all."

Johnston said he would bring the matter of press coverage and attendant economic matters before the Council during the current summer meeting.

Relations between the professional staff of IAS and the working press attempting to cover IAS open technical sessions had been growing steadily worse during the past year. Earlier flare-up occurred at the Denver space symposium last March sponsored jointly by IAS and the USAF Office of Scientific Research. USAF flew a special plane to Denver with daily newspapermen and magazine writers to cover the conference which drew a record working press attendance for an affair of this type. However on arrival in Denver it was found that no copies were available for many of the highly technical papers to be presented and only a single copy was available for the remainder. Due to the efforts of USAF personnel, a duplicating machine was procured and copies eventually made for the working press.

Written protests on the Denver situation were sent to the IAS staff by AVIATION WEEK, the Associated Press and New York Times. It also stirred talk of a formal protest to be made at the Aviation Writers Assn. convention in Houston last month, but the matter did not reach the convention floor.

Los Angeles newspapermen expressed resentment over the IAS press policy at the summer meeting. They noted the irony of the fact that the aircraft, missile and space technology companies that financially support the Institute are constantly after newspapermen and technical magazine writers to write about their new technical developments but that when they are discussed in IAS meetings virtually no effort is made to provide for press coverage. They also pointed out that the current IAS staff attitude of indifference to outside press coverage was unique among all the major professional technical societies, most of whom provide extensive press facilities for major conferences.

News Digest

Douglas Aircraft Co.'s Santa Monica Division will reduce employment from its present 25,000 to 20,000 persons by Dec. 1. Work force will be reduced at average rate of 235 per week. Rapidly diminishing backlog of DC-6 and DC-7 series transports has necessitated the reduction. Stages of production and union seniority agreements will determine basis of layoffs. Included in the 5,000 are production and some clerical workers. No engineers are included.

Atlas intercontinental ballistic missile equipped with a main sustainer engine and two boosters was static-tested last week at Cape Canaveral. This was the first time that an Atlas housing all three engines had been tested. Test, which lasted approximately 20 sec., indicates that a launching of the first fully powered Convair missile will probably be attempted soon.

Bristol Type 192 helicopter, powered by twin Napier Gazelle turbine engines, made its first flight at Bristol Aircraft Ltd. Weston Division field.

West German decision on selection of new fighter equipment will not be made until October, according to Defense Minister Franz Josef Strauss.

Airways Modernization Board last week signed $1.4 million contract with Radio Corp. of America to develop and provide experimental automatic ground-air-ground communication system (AGACS). RCA won out over 13 other competitors in recent AMB competition (AW June 30, p. 19).

Tennessee Gas Transmission Co. has transferred controlling interest (93.4%) in Grand Central Rocket Co. to Petro-Tex Chemical Corp. of Houston, Texas. A major producer of butadiene, Petro-Tex is jointly owned by Tennessee Gas Transmission and Food Machinery & Chemical Corp.

Air Force last week fired its second Thor Able test vehicle bearing a live mouse over 5,000 miles from the USAF Missile Test Center, Cape Canaveral, Fla. First flight of the vehicle employing a Thor first stage plus the second stage Vanguard was in April (AW April 28, p. 37). Air Force hoped to recover the mouse alive in the scaled-down ICBM nose cone.

ADVANCED Sikorsky HSS anti-submarine helicopters feature automatic flight stabilization using Hamilton Standard electronic components. More than 50 types of turbine or rocket powered aircraft and missiles also use Hamilton Standard equipment, propellers, or electronic devices because of Hamilton Standard's leadership in design and production.

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Senate Fiscal Group Plans MATS Study

Survey could precipitate MATS showdown; tariff manual puts service's U.S.-Paris rate at $91.

By Ford Eastman

Washington—Senate Subcommittee for Defense Department Appropriations served notice last week that it will take a searching look at Military Air Transport Service policy and practices before approving funds requested for Fiscal 1959.

Sen. Dennis Chavez (D.-N. M.), subcommittee chairman, submitted a list of 16 questions to Dudley C. Sharp, Air Force Assistant Secretary for Materiel, which could precipitate a showdown in the long-standing controversy between MATS and civil carriers over transportation of Defense Department passengers and cargo.

Sen. Chavez told Sharp that the subcommittee has received a great number of complaints from air carriers concerning practices of MATS in letting cargo and passenger contracts as well as comments on the prices MATS has been paying commercial air carriers.

Earlier, the House Military Operations Subcommittee, headed by Rep. Chet Holifield (D.-Calif.) said that MATS, by running a scheduled airline for overseas operation, "was in effect pre-empting a field which should be occupied by commercial air carriers" (AW June 30, p. 31).

MATS Revenue

Beginning July 1, MATS was placed on an industrial fund basis under which it charges agencies for its service. It is estimated that revenues produced by the program will amount to $300 million in Fiscal 1959.

Coinciding with the program, MATS published a tariff manual in which it detailed its rate and charges applicable to government and quasi-government agencies as common users and those not entitled to common user rates. Common user rates are far below commercial airline rates, while those not entitled to the common user rates must pay a higher tariff.

For example, the fare for a MATS passenger between the U. S. East Coast and Paris is $91. Commercial airline passengers between New York and Paris must pay $455 first class, $335 tourist class or $272 for economy class.

From Tokyo to the U. S. West Coast, the common user fare on MATS is listed at $132. First class fare from Tokyo to the West Coast on commercial airlines is $650, tourist fare is $488. From Hawaii to the West Coast on MATS, the fare is $48 as compared with $178 first class and $133 tourist on commercial airlines.

Typical Fares

Other typical fares charged common users of MATS between the U. S. and overseas points include:

- **East Coast-Bermuda $20** passenger fare; cargo rate is 69 cents per pound.
- **East Coast-Argentina $33** and $1.13 for cargo.
- **East Coast-Frankfurt, Germany, $96** and $3.37.
- **East Coast-Madrid $92** and $3.21.
- **Miami-Rio de Janeiro $130** and $3.62.
- **West Coast-Anchorage $29** and 96 cents.
- **West Coast-Manila $152** and $5.17.
- **Miami-Puerto Rico $29** and 80 cents.

The MATS tariff report explained that to compute fares not listed under the common user class, the nautical mileage should be multiplied between the two desired points by $.031 for passenger fare and by $.0001 for the cargo rate per pound. For transportation of persons and property which do not qualify for common user rates, the rates are similar to standard airline tariffs. Common user hourly rates for agencies chartering MATS aircraft are listed as follows:

- **Boeing C-97, $319.**
- **Lockheed C-121, R7V, $434.**
- **Douglas C-124A, $345.**
- **Douglas C-124C, $396.**
- **Douglas C-133, $1,149.**
- **Douglas C-118 R6D, $306.**

Because of the complaints received by his subcommittee, Sen. Chavez told Secretary Sharp he wanted facts concerning MATS practices to be placed in the record and that later outside witnesses, such as the Air Transport Assn. and Air Line Pilots Assn., would be called upon to testify.

Chavez' Questions

The questions Chavez asked Sharp to prepare answers to are:

- **"How much commercial air carrier** transportation does MATS propose to purchase in the future? I ask this question in the light of our committee report last year when we set a formula for MATS of 40% passenger and 20% cargo purchase from commercial air carriers.
- **"Does MATS presently have any price** standard and does MATS have any data on what is compensatory for a carrier to charge per passenger mile, per ton mile and per plane mile, depending on the type of equipment employed?
- **"How does MATS propose to let bids** in the future? Are you going to continue the three month bid period or are you going to lengthen it to one year?
- **"Does MATS have any formula for** distributing its commercial requirements so that virtually all of the business does not end up in the hands of a few large carriers? Is it not in the interest of the airlift potential to distribute MATS requirements equitably?
- **"Does MATS have any compelling** reason for demanding pressurized equipment for personnel when several hundred non-pressurized planes are presently in commercial use domestically and several international carriers still use non-pressurized DC-4s?
- **"MATS claims its fleet must be** constantly exercised. How many hours does this mean per day? Have you ever considered a live exercise of the Civil Reserve Air Fleet, and how do you expect it to perform if you've never had a live test?
- **"MATS testimony indicates that** its main function is to support the Strategic Air Command. Do you need 800 stewards and stewardesses to accomplish this mission?
- **"With reference to the new indus**trial" fund rates, reported to be ap-

MATS Contracts TWA

Washington—Military Air Transport Service (MATS) last week contracted Trans World Airlines to fly 52 westbound transatlantic charter flights from Frankfurt, Germany, to the U. S. East Coast during July. The contract, one of the largest peacetime airlift orders awarded a single carrier, involves the movement of more than 3,500 military personnel and their dependents from overseas bases to New York's International Airport and McGuire Air Force Base.

TWA pointed out that the military charter contract came at a time when westbound tourist traffic is at a seasonal ebb. The airline also noted that the contract "demonstrates the flexibility of a scheduled carrier to accommodate its services to military defense traffic."

proximately 2.07 cents per mile, how is that figure arrived at? What costs are included in computing it? Itemize those elements in those costs, and also those that are not included.

• **"How much do you anticipate** the Air Force Industrial Fund will take in during Fiscal Year 1959 from the operation of MATS?

• **"In carrying out the recommendations** of the Hoover Commission, has the Defense Department set up a single manager for transportation? Why was the traffic management responsibility for air transportation given to the operating agency, MATS?

• **"By setting up the Industrial Fund,** will there be a tendency on the part of Defense to use MATS aircraft with their lower rates in preference to commercial carriers?

• **"Since MATS has now gone on** to an industrial fund basis does this mean there are no longer any appropriations required for the transport operation of MATS, in view of the revenue expected to be taken into the fund?

• **"Is the Air Force concerned about** the plight of the major cargo carriers now facing a financial crisis?

• **"In view of the great increase** in civil air carrier airlift capacity, what plans are being made by the Air Force to preserve the national defense, the airlift capability of the present civil airfleet?

• **"What plans are being made to assign** more business to the commercial air carriers to assist them in buying modern long-range aircraft at no expense to the taxpayer, while augmenting our total national airlift capability?"

Civil Complaints

The civil air transport industry has long complained that MATS is operating a huge world-wide scheduled air transport system and, in many instances, competes directly with scheduled civilian carriers.

Stuart G. Tipton, ATA president, testified before the Senate Commerce Committee earlier that MATS diverts an estimated $100 million annually in revenues from commercial airlines and that even a greater diversion may develop. The bulk of MATS traffic moves on routes that duplicate those certificated to U. S. flag carriers, he added, and its traffic volume has doubled between 1954 and 1957 to 771 million ton miles.

MATS vs. Flag Lines

In 1956, Tipton said, the two largest American flag carriers, Pan American and Trans World, operated a total of 53 million revenue plane miles over the Atlantic, while MATS flew 62 million plane miles. During the same year in the Pacific, Pan American and Northwest Orient Airlines flew 26.8 million revenue plane miles as compared with 40 million plane miles operated by MATS.

Besides diverting traffic from commercial airlines, the industry claims that government operated air transport services are too costly, divert attention from MATS primary mission to provide airlift support to combat forces and reduce emergency airlift capacity.

Commercial air carriers urge that transportation by MATS be authorized only after civil airlines have been fully utilized. This, they claim, would aid airlines in purchasing equipment, based on anticipated business volume; provide more aircraft that would be available to the Defense Department in the event of an emergency, and still leave a sizable volume of traffic to MATS. The carriers contend that it also would reduce over-all costs to the government and ensure that MATS equipment would be readily available for its primary mission to provide airlift for initial emergency combat deployments and other military requirements.

USAF Testimony

Sharp told the Senate Defense Appropriations Subcommittee that he believed the defense posture would be seriously weakened if MATS readiness to carry out emergency missions were in any way reduced.

He said today's emergency airlift requirements must be met with today's resources and that the combined military and civil cargo fleets fall short of the needs. Recent estimates of emergency airlift requirements made by the Joint Chiefs of Staff show a steadily rising trend, Sharp testified. He added that the deficits are primarily in cargo airlift. He told the subcommittee expansion efforts in the airline industry are mainly in the passenger-carrying area, whereas wartime demands are for cargo airlift capacity.

Economic Role

Sharp said that it is only through the MATS fleet—which is primarily a cargo carrier in wartime but it is also capable of troop movement or aeromedical evacuation—that the wartime cargo deficits can be held to manageable levels. He added that the Air Force has consistently held that attainment of the emergency aircraft utilization rate can be assured only if the system is operating in peacetime within reach of the higher rate necessary in an emergency. "We feel," he said, "that MATS' current utilization rate, if anything, falls short of such a reasonable peacetime rate."

Operating the aircraft and the system, Sharp said, produces an airlift capability. It represents good management and economical use of the taxpayer's dollar to turn this capability into meeting peacetime airlift needs of the Defense Department, which otherwise, he said, would have to be met by further outlays of the taxpayer's dollar.

Sharp said that during Fiscal 1958 an estimated $69.8 million in traffic was contracted with commercial carriers for transportation of passengers and cargo. This amount, he said, represents 37.9% of MATS' passenger operations and 9.3% of its cargo operations as compared with the 40% passenger and 20% cargo rate urged by Congress.

Napier Proposes Turboprop DC-7

By L. L. Doty

Washington—Plans to expand the useful life of the Douglas DC-7 and to broaden its appeal in the used-plane market by converting the aircraft to turboprop power are being pushed by Aircraft Supply Co. of Washington.

Because of industry concern over the depressed used-plane market (AW July 7, p. 26) the program is attracting strong attention among airlines seeking an outlet for their surplus aircraft. As U. S. representatives of D. Napier and Sons, British aircraft engine manufacturer, Aircraft Supply is sponsoring the conversion plan with the Napier Eland axial-flow turboprop engine as the new powerplant.

Douglas Aircraft, which would be asked to undertake conversion activities should the sales program catch on, has considered the feasibility of re-equipping the DC-7 with several types of turboprop engines as a means of putting the airplane back into competition.

The manufacturer indicated to AVIATION WEEK that it is ready to cooperate on the Napier project once a firm market for the converted DC-7 has been established.

As yet, the proposed project has not attracted any takers. Aircraft Supply is convinced, however, that once the problem of an over-supply of aircraft becomes widespread the program will draw the active support of both the airlines and manufacturers as an important means of relieving a glutted used-plane market.

In its program, the company is stressing the re-powering of the DC-7 as a way of stretching the airplane's life into a long period of effective competition against turbine-powered aircraft now coming off the production line. It emphasizes the theory of lower costs through improved productivity of aircraft presently in airline operation.

Cost of conversion is placed at an estimated $1 million. Most engineers agree that the DC-7 can be repowered

with turboprop engines without any redesign of wings or airframe.

Block speed of the converted aircraft powered with the Eland turboprops is estimated at 350 mph. by Aircraft Supply as compared with a 300 mph. block speed of the piston-powered DC-7.

The company estimates that an increased revenue potential of $500,000 per year per aircraft will result with the 50 mph. speed increase at 3,000 hours annual utilization with a revenue rate of 6 cents per seat mile.

Operating Costs

In estimating direct operating costs of the Eland-powered DC-7, these basic assumptions have been used:

- **Fuel costs will run 14 cents per** gallon for kerosene and $7 per gallon for oil.
- **Eland engine labor and** maintenance material will average $60 per aircraft hour.
- **Pilot and copilot pay** will be increased by $2 per hour due to higher block speeds.
- **Depreciation rate of seven years** at a 15% residual value has been adopted for the purposes of figuring costs. The seven-year service life has been set as a standard depreciation rate for the scheduled airlines by the Civil Aeronautics Board. However, American Airlines has complained to the Board that the extended life would increase its "exposure to retirement loss" on a portion of its DC-7 fleet by "over $17.8 million" because of the airline's plans to retire the entire fleet by 1961.

Napier Eland engine costs have been estimated by Aircraft Supply at $160.75 per hour. Direct operating costs of the present DC-7 minus engine and fuel costs and tax and depreciation expense is figured by the company at $157.80 per hour. By combining the two figures, Aircraft Supply arrives at a direct operating cost of the Eland DC-7 of $318.55 without the depreciation factor.

For purposes of estimating depreciation costs, the company assumes a book value of $2 million for the present DC-7. This, coupled with the $1 million conversion cost, gives an adjusted book value of $3 million. Annual depreciation, therefore, amounts to $364,300 after taking into account the 15% residual value of $450,000.

At a depreciation cost of $121.43 per hour, total Eland DC-7 direct operating costs are placed at $439.98 per hour compared to $453.60 per hour for the present DC-7.

Cost Comparison

Based on purchase price of the airplane, direct operating costs between the present DC-7 and the converted model are compared this way:

- **At a purchase price of $350,000,** the present DC-7 direct operating costs are set at $1.25 per mile compared to $1.06 per mile for the converted plane at the same purchase price plus conversion costs of $1 million.
- **Direct operating costs** of $1.34 per mile are established for the present DC-7 costing $1 million compared to $1.14 for the Eland DC-7 at the same purchase price plus conversion costs. Some brokers estimate that $1 million is close to the top price DC-7s will draw in today's market.

Napier recently converted a Convair 340 to turboprop power and is presently conducting an extensive sales campaign throughout the U. S. and Europe in hopes of marketing the revamped model. Aircraft Supply estimates converson costs of either the Convair 340 or 440 at $400,000.

As in the case of the DC-7, the company points out that, as the book value of the Convair is reduced, levels of direct costs will decline.

USAF Surveys Viscount Crash

By Robert H. Cook

Washington—Positive control of all military and civil IFR and VFR flight procedures by one agency was urged last week by Air Force investigators who blamed inadequate air traffic control procedures and radar surveillance equipment for the May 20 mid-air collision of a Capital Airlines Viscount and a National Guard T-33 over Brunswick, Md. (AW May 26, p. 25).

A comprehensive military study of the accident, which took the lives of 11 persons aboard the airliner and a passenger of the jet, was prepared by USAF's Aircraft Accident Investigation Board and followed closely on the heels of a Civil Aeronautics Board investigation conducted by Vice Chairman Chan Gurney (AW July 7, p. 38).

Major recommendations made by the military after its investigation:

- **System which permits VFR and IFR** flights in the same area should be changed to provide positive control of both by one agency.
- **All air traffic control and detection** equipment such as radar should be combined for the use of one agency.
- **Government committees established** for the purpose of improving control of air traffic and safety of flight should be required to accelerate their activities.
- **Action should be expedited on** the development, procurement and installation of anti-collision warning devices permitting automatic detection of the proximity of other aircraft, calculation of the rate of closure and indication of the course to avoid collision.
- **Ground radar equipment** should be improved so that altitude as well as azimuth can be determined.
- **Rules should be established** to provide adequate visibility standards.
- **Air Force planes offering** small reflective capability should be equipped to present a better radar reflection.
- **All aircraft should be painted with** a conspicuous substance that reflects light, to assist in visual perception.

The report scored the "inadequacy of existing air traffic procedures which allow two or more aircraft to occupy the same airspace at the same time and which relies primarily on the ability of individual pilots to see and avoid one another." The report said a contributing factor to the accident was the inadequacy of radar equipment serving high density traffic airways in the Washington-Baltimore area. The military board also listed visibility restrictions in the Viscount and difficulty in observations from the jet trainer at "wide starboard angles" along with "complacency and/or erroneous assumptions by pilots that IFR clearance provides collision immunity even under VFR conditions."

The Air Line Pilots Assn., which is expected to release results of its own investigation soon, apparently is in general agreement with the military report and the Air Force board.

Although several eye witnesses told the CAB the T-33 seemed to have overtaken the Viscount, the Air Force investigation estimates that the two planes were flying at approximately the same speed of 240 knots and collided at a horizontal angle of "as little as 30 degrees." CAB accident investigators have estimated the angle to be as much as 45 degrees, and ALPA believes the jet trainer was flying about 40 knots faster than the airliner.

The Air Force board said the T-33 "probably" approached beneath the number two propeller of the Viscount just beyond the "natural" visibility level of 10 degrees below the horizon for the airline pilot. Placing the Viscount about 20 to 30 degrees above the starboard side of the jet, the military said the visibility of the T-33 pilot was restricted by his P-4 helmet and the front seat headrest.

With the jet trainer in a shallow climb of 1,000-1,200 feet per minute, the angle of vertical collision could have been 10 degrees, the Air Force said. Capt. Julius McCoy, pilot and lone survivor of the accident, was unable to recall either his speed or rate of climb in testimony before the CAB.

ALPA contends, on the basis of a study of speeds, angles and eye witness testimony that the National Guard plane made an approximate right bank of 15 degrees into the airliner.

Boeing Rolls Out First American Airlines 707

American Airlines' first Boeing 707 jet transport is rolled out at Boeing Airplane Co. Transportation Division plant. Aircraft, first of American's 30 jet aircraft on order, is scheduled to fly in August and will be tested in CAA certification program. Seven others now are being completed on Boeing assembly line. By April 1, 1959, American expects to provide transcontinental jet service.

New York-San Juan Fare Probe Ordered

Washington—Fares charged by Eastern Air Lines, Pan American World Airways and Trans-Caribbean Airways between New York/Miami and San Juan, Puerto Rico, will be investigated by the Civil Aeronautics Board.

Recent CAB action in granting Pan American and Eastern 6% fare increases for first class and tourist fares over this route was strongly opposed by the Commonwealth of Puerto Rico. The carriers followed up the fare increase with requests to reduce their "thrift class" fares from New York to San Juan from $52.50 to $45. Trans-Caribbean, which has been offering a $45 fare between these points, said the requests, if granted, would constitute unfair competition and called for an investigation.

Vice Chairman Chan Gurney cast the lone dissenting vote for a full investigation of the rate structure, saying that he believed the fare increase was justified by the over-all earnings rate of the two carriers and that the third-class reduction was reasonable as a means of competing with a third carrier in the New York-San Juan market. He said he viewed the Board's action in calling for an investigation as the adoption of a "strange precedent by instituting an investigation when carriers reduce their fares to meet competition."

Questioning the "unusual timing" of the Pan American and Eastern reductions, member G. Joseph Minetti concurred in the Board action with the observation that "presumably . . . the $45 fare is only economically feasible if subsidized by fare increases in other categories of service."

Minetti, along with member Louis J. Hector, opposed the granting of the 6% increase to the carriers in the Service to Puerto Rico Case. While Hector concurred with the Board's decision to investigate first and tourist-class fares, he objected to investigation of the $45 thrift fare, declaring that there were no grounds on which to judge the reduction as unjust or unreasonable.

AMB Delineates Taxi Control Needs

Washington—Representatives of 24 avionics manufacturers attended a briefing session last week outlining Airways Modernization Board's upcoming design competition to select a contractor to develop an experimental Taxiing and Routing of Aircraft Coordination Equipment called TRACE.

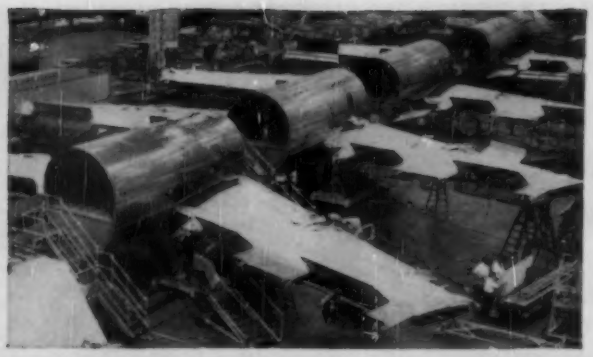
Equipment is intended to speed the flow of ground traffic at the airport, particularly during peak load and poor visibility conditions, by giving ground controller a display of all aircraft on runways and taxi-strips, giving pilots taxiing instructions (AW July 7, p. 23).

Fifteen of the companies represented indicated their intention of submitting bids, the remainder were undecided. Proposals are due at AMB headquarters in Washington by Aug. 11, at 5 p.m.

AMB requirements for the experimental TRACE, outlined by project engineer Albert F. Hopkins, include the following:

- **Aircraft detection device(s)** capable of determining the position of each aircraft on airport runways and taxi strips, either on a continuous basis or on a "block system" basis. The system is to be able to handle 20 aircraft simultaneously and have the capability of being expanded to handle 100 or more.
- **Ground controller display** to show both actual and programmed positions of all vehicles operating in the system relative to an overlay of the airport configuration.
- **Ground traffic programmer** to accept data from aircraft detection devices and from the ground controller, process data for controller's display and control airport visual aids.
- **Visual aids** consisting of standard runway taxi lights, billboard displays or other devices to indicate taxi instructions to pilots.

AMB says the system must operate reliably with both moving and stationary aircraft, be suitable for economical installation at existing, as well as new, airports. The experimental system, to be delivered within 12 months, will be installed at AMB's new National Aviation Facilities Experimental Center at Atlantic City, N. J., for evaluation.



REPORT ON PRODUCTION

AHEAD-OF-SCHEDULE production of Boeing 707 jetliners reflects the efficient manufacturing techniques developed by Boeing while producing more than 1600 large multi-jet aircraft ... more than any other company in the world. Boeing methods, superior design experience and new facilities combine to produce outstanding jet aircraft. Boeing KC-135 jet transport-tankers, built in this same plant, are setting Air Force records for minimum maintenance and maximum reliability.

SUB-ASSEMBLIES completed in a huge new Transport Division facility are fed into final assembly area. In every phase of production, unyielding standards of quality control are adhered to rigidly. Incorporated in the 707, and the shorter-range 720, are all the benefits of Boeing's 10 years of multi-jet production experience.

INFINITE CARE assures assembly and production at the same high level as advanced Boeing design. Every step, every detail, is checked, double-checked, and checked again.

SLEEK 707s ROLL OUT AHEAD OF SCHEDULE. Within months they'll enter commercial service. By that time, Boeing multi-jet transport-type aircraft will have logged more than 200,000 hours of flight experience. The 707 and the 720 will provide airlines with a family of jetliners loaded with passenger appeal, and designed and built for profitable operations on short, medium and long-range routes.

These airlines already have ordered models of the Boeing family of jetliners:
AIR FRANCE • AIR INDIA • AMERICAN • B.O.A.C. • BRANIFF • CONTINENTAL • CUBANA
LUFTHANSA • PAN AMERICAN • QANTAS • SABENA • SOUTH AFRICAN • TWA • UNITED • VARIG

BOEING
Family of jet airliners

Airline Traffic—12 Months Ending March 31, 1958

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	7,489,875	5,012,492	64.7	19,640,418	8,588,088	83,425,885	593,685,850	56.7
Braniff	2,043,863	891,777	58.7	3,256,616	1,441,215	5,488,673	95,817,125	47.2
Capital	4,054,725	1,566,834	58.6	5,687,252	2,516,108	4,726,298	163,070,970	47.3
Continental	840,371	383,243	53.5	1,140,315	513,141	1,668,266	40,123,700	44.2
Delta	2,680,211	1,334,251	58.1	4,346,443	2,781,245	10,038,661	145,580,307	53.5
Eastern	7,813,842	4,342,698	58.19	11,212,031	5,133,507	15,102,422	450,068,453	48.67
National	1,337,368	883,966	57.7	3,228,718	579,710	5,268,197	94,874,949	48.6
Northeast	836,179	321,583	48.0	787,628	288,986	816,431	32,722,554	40.2
Northwest	1,413,699	987,456	56.1	4,789,581	2,438,318	9,793,155	110,030,497	49.5
Transworld	4,605,272	3,736,509	63.0	12,591,714	6,666,601	25,025,736	402,499,045	55.4
United	6,323,853	4,673,278	64.6	28,924,213	9,009,838	58,378,694	545,220,829	56.5
Western**	1,258,708	640,491	58.8	2,825,729	974,104	2,730,761	67,696,710	52.1
INTERNATIONAL								
AAXICO*	.....	.....	....	.....	.....	.....	.....	....
American	133,346	103,370	59.1	148,089	4,695	3,561,521	14,639,955	64.1
Braniff	46,800	96,721	52.6	202,602	.....	933,761	11,764,746	47.8
Caribbean-Atlantic	232,832	16,367	55.2	18,888	.....	39,462	1,774,962	60.2
Delta	69,426	82,393	60.8	87,989	.....	555,713	9,834,558	53.3
Eastern	342,113	463,522	58.82	1,114,645	.....	1,143,991	50,119,690	58.82
Mackey	89,540	18,659	43.6	.....	.....	32,676	2,156,225	47.4
National	81,753	58,560	46.2	110,728	51,721	458,335	6,810,153	44.1
Northwest	121,517	267,012	54.6	12,489,215	217,167	7,513,848	48,711,994	66.1
Pan American								
Alaska	65,417	73,263	60.8	425,415	.....	2,547,031	10,570,685	53.7
Atlantic	1,108,698	1,461,063	62.4	14,105,786	.....	25,796,136	194,149,175	59.6
Latin America	1,216,617	1,303,038	65.4	4,651,139	.....	51,040,725	181,326,081	63.5
Pacific	272,269	1,018,815	72.8	12,181,917	.....	17,146,469	135,293,513	66.2
Panagra	138,199	171,957	57.1	764,393	.....	4,849,383	24,571,233	59.7
Resort	2,047	12,625	93.0	.....	.....	44,132,570	45,366,703	77.7
Trans-Caribbean*	.....	.....	....	.....	.....	.....	.....	....
Transworld	287,915	762,971	62.0	10,201,280	.....	8,256,163	98,579,021	62.9
UMCA†	1,880	618	33.1	.....	.....	27,468	91,477	44.7
United	101,578	253,403	65.6	1,341,244	.....	818,799	28,038,654	61.5
Western**	13,397	20,832	55.4	7,377	.....	49,078	2,310,961	58.3
LOCAL SERVICE								
Allegheny	447,706	77,920	44.2	103,940	189,166	183,722	7,915,877	44.0
Bonanza	163,248	36,217	45.8	52,979	28,641	76,250	3,618,647	43.9
Central	126,188	25,020	34.8	49,420	24,668	88,655	2,561,181	31.0
Frontier	227,419	61,789	52.1	215,549	90,628	733,595	6,974,973	61.7
Lake Central	168,114	26,660	35.7	35,130	161,333	.....	2,750,923	39.1
Mohawk	429,637	81,696	47.8	72,808	158,009	252,385	8,283,206	48.5
North Central	679,571	110,536	46.3	262,412	357,670	.....	11,228,995	46.8
Ozark	408,918	67,364	42.5	136,888	180,344	170,379	6,927,306	44.3
Pacific	351,011	76,477	53.6	118,557	55,771	81,842	7,549,146	51.6
Piedmont	407,147	84,736	52.9	164,288	109,455	162,265	8,555,921	52.4
Southern	214,244	38,912	38.4	112,537	123,906	15,574	3,981,603	37.9
Trans-Texas	242,342	54,966	38.6	164,925	95,935	290,937	2,802,906	39.1
West Coast	259,118	46,253	48.95	62,500	26,181	66,065	4,559,892	46.26
HAWAIIAN								
Hawaiian	406,675	61,094	59.3	49,364	.....	1,450,776	6,524,038	56.1
Trans-Pacific	189,708	27,326	56.4	14,453	.....	117,922	2,257,740	56.8
CARGO LINES								
Aerovias Sud Americana	.....	.....	....	.....	.....	8,670,524	8,670,524	80.5
Flying Tiger	109,482	505,439	99.1	453,108	324,340	88,408,073	139,729,775	84.2
Riddle	.....	.....	....	431,917	250,751	1,964,103	20,323,701	67.1
Seaboard & Western*	.....	323,738	100.0	.....	.....	17,642,983	50,037,522	74.74
Slick	63,199	293,689	96.93	688,065	511,596	38,648,573	69,217,002	78.93
HELICOPTER LINES								
Chicago Helicopter	72,036	1,195	35.2	24,439	.....	.....	138,716	29.6
Los Angeles Airways	30,805	1,128	53.5	47,063	21,196	.....	175,988	59.1
New York Airways	70,473	1,309	38.2	19,614	10,715	6,870	163,516	40.6
ALASKA LINES								
Alaska Airlines	65,895	26,898	32.2	588,454	.....	3,389,301	6,700,348	42.8
Alaska Coastal	52,333	4,659	63.6	48,748	.....	49,373	570,260	64.3
Cordova	19,326	4,812	54.4	43,773	.....	1,345,083	1,870,424	49.1
Ellis	57,937	3,340	57.1	24,688	.....	31,070	395,351	67.9
Northern Consolidated	20,860	6,707	45.8	282,834	.....	709,464	1,726,785	61.6
Pacific Northern	109,380	106,118	51.9	1,199,637	.....	3,026,445	15,730,891	60.1
Reeve	10,585	7,792	36.2	216,513	.....	554,644	1,616,682	46.4
Wien Alaska	28,248	9,399	34.1	396,863	.....	2,231,535	3,604,516	62.8

* Not available. ** Western Air Lines strike—2/21/58 to 6/1/58. † Uraba, Medelin & Central Airways

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

SHORTLINES

► **Civil Aeronautics Board** has suspended increased passenger fares for 160 days between points in Alaska and the continental U. S. by Alaska Airlines, Northwest Airlines, Pacific Northern Airlines and Pan American World Airways. During the suspension, Civil Aeronautics Board will investigate need for increased fares.

► **Delta Air Lines** plans to build a $10 million, 356,800 sq. ft. jet overhaul base at its headquarters at Atlanta Airport. The new facility, scheduled to be completed in December, 1959, will have a 100,800 sq. ft. two-story operational shop; a 89,600 sq. ft. engine overhaul shop; a 60,800 sq. ft. warehouse; a 9,600 sq. ft. plating and accessory test shop and a 71,400 sq. ft. hangar to accommodate three Douglas DC-8 airliners. Two other areas in the new facility will have an area of 24,120 sq. ft. There also will be a 168,000 sq. ft. aircraft apron and a 276,250 sq. ft. automobile parking lot.

► **Lufthansa-German Airlines** has joined the World Wide Plan which allows a traveler to arrange financing of air transportation. Known as the "Go Now, Pay Later" plan, the service requires the traveller to fill out only one form. An application can be processed in 24 hr. if necessary.

► **North Central Airlines** carried 70,875 passengers in June, a new monthly record for the carrier.

► **Northwest Airlines** estimates operating revenues for the first six months of 1958 at $43,985,000 as compared with $38,342,000 for the corresponding period last year. The 1958 figure represents $5,643,000, or 14.7% increase for the period. Estimated profit from operations, taxes and property disposal was $1,140,000 as compared with $650,000 last year, an increase of 75.4%.

► **L. B. Smith Aircraft Corp.** of Miami has made arrangements with Vickers Armstrongs, Ltd. to handle repair, conversion and modification of the Vickers' turboprop Viscount. L. B. Smith Corp. has performed Viscount interior conversions for several large corporations, but this is the first designation of the company as an official Viscount repair station.

► **Vickers Viscounts** have flown over 1.5 million airline hours for a total of 12 billion passenger miles since they entered regular scheduled service in April, 1953, according to the manufacturer, Vickers-Armstrongs.

AIRLINE OBSERVER

► American Airlines and Pan American World Airways are now working closely with the Civil Aeronautics Administration in a move to resolve differences of opinion on air traffic control procedures for jets. Basis for the differences is airline stress on economy of operation versus CAA's drive to increase the rate of traffic flow. For example, airlines want holding patterns for jets at 20,000 ft. because of high fuel consumption at low altitudes. CAA claims that the acceptance rates of airports increases as holding altitudes are decreased and is considering jet holding patterns as low as 4,000 ft. Airlines contend that once a jet descends below 20,000 ft., it is committed to a landing because of high rate of fuel consumption in a possible climb-out resulting from a missed approach. CAA argues that a decrease in traffic delays will compensate for fuel consumption at low altitudes.

► **Delay of Iberia Air Lines of Spain in making a decision on a powerplant for its Douglas DC-8s has resulted in a bitter sales battle among aircraft engine manufacturers. Pratt & Whitney, which was confident of getting its J75s into Spain, is now drawing tough competition from Rolls-Royce which recently flew a Vulcan bomber powered by four Conway bypass engines to Madrid for Iberia demonstration. P&W case against the bypass engine has been considerably weakened by the recent revelation of its own bypass development project for the airline market.**

► Denmark has signed a bilateral air transport agreement with the Rumanian government. Prior to the agreement, Brussels was the only city outside the Iron Curtain served by the Rumanian airline, TAROM. The carrier operates a fleet of Russian Il-14s and Li-2s.

► **Civil Aeronautics Administration has signed a contract with Raytheon Manufacturing Co. for six long-range radars and 23 Amplitron units at a total cost of $5.8 million. The contract increases the number of radars on order from Raytheon to 33 and the number of Amplitrons to 33. Equipment is expected to detect a small tactical jet aircraft at a distance of 135 mi. up to altitudes of 60,000 ft. and larger aircraft at 200 mi. and 100,000 ft.**

► Boeing has invested approximately $10 million in the development of a sound suppressor-thrust reverser for its 707 jet transports. Units are now in quantity production at Rohr Aircraft's Chula Vista, Calif., plant.

► **Ghana Airways Ltd. has been organized for domestic and international air transportation with a nominal capital of $1,120,000, 60% of which has been subscribed by the government of Ghana. British Overseas Airways Corp.'s Associated Companies Ltd. has subscribed for the balance of the capital. The new carrier will begin service with a once-weekly flight between Accra and London with a Boeing Stratocruiser. Equipment covering international services will be chartered from BOAC. All existing domestic service will be taken over by Ghana Airways from West African Airways Corp. in October.**

► Port of New York Authority says it has received no requests from either Boeing or Pan American to operate the Boeing 707 turbojet transport into Idlewild. Pan American's first model, which is scheduled for delivery July 15, has been operating into Boston, Baltimore and Miami in current Civil Aeronautics Administration certification flights.

► **British Aircraft manufacturers are concerned that limited credit terms offered to potential buyers are hurting British sales in the world aircraft market. W. E. Nixon, chairman of de Havilland Aircraft, says the British manufacturers' inability to offer long-term credits on the sale of aircraft presents "a severe handicap" in efforts to compete with the U. S.**

► Trans World Airlines hopes to begin nonstop service in both directions between Chicago and Paris about August 1. Service is dependent on a move of U. S. customs and immigration services to O'Hare from Midway. TWA nonstop Chicago-Paris service operating since May 3 has been stopping at New York on the west bound flight to clear customs.

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THE WONDERFUL WAY TO MEXICO CITY

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Welcome to your reserved seat on a fiesta air cruise to Mexico City—Western's incomparable Champagne Flight. You're off to a wonderful trip!

Here's your chilled glass of private stock champagne. Be our guest for a leisurely, full-course dinner—complete from appetizer to pastry cart—while you relax in real Mexican atmosphere. *Magnifico!*

Western's Champagne Flight combines Old World charm and New World luxury for the finest hours in the sky today. And you can enjoy through one-carrier service from all the West!

It's a real "fiesta flight"—on Western Airlines, the wonderful way to Mexico City!

Western's Champagne Flights are nonstop from Los Angeles—with thru connections from all the West. Call Western Airlines.

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* **Defensive Systems**—Enemy aircraft trying to break through America's air defenses now face fast interceptors like the Northrop F-89 *Scorpion* carrying such powerful armament as the Douglas *Genie*. This atomic missile can destroy an attacking formation with even a proximity explosion.

sneak attacks over our own or friendly territory.

Rapid development of *Genie* from design and test stages into quantity production is typical of the speed and thoroughness of the Douglas approach. To date Douglas has produced almost twenty thousand experimental and operational missiles for the Army, Navy and Air Force in *all four major categories:* air-to-air, air-to-surface, surface-to-air and surface-to-surface.

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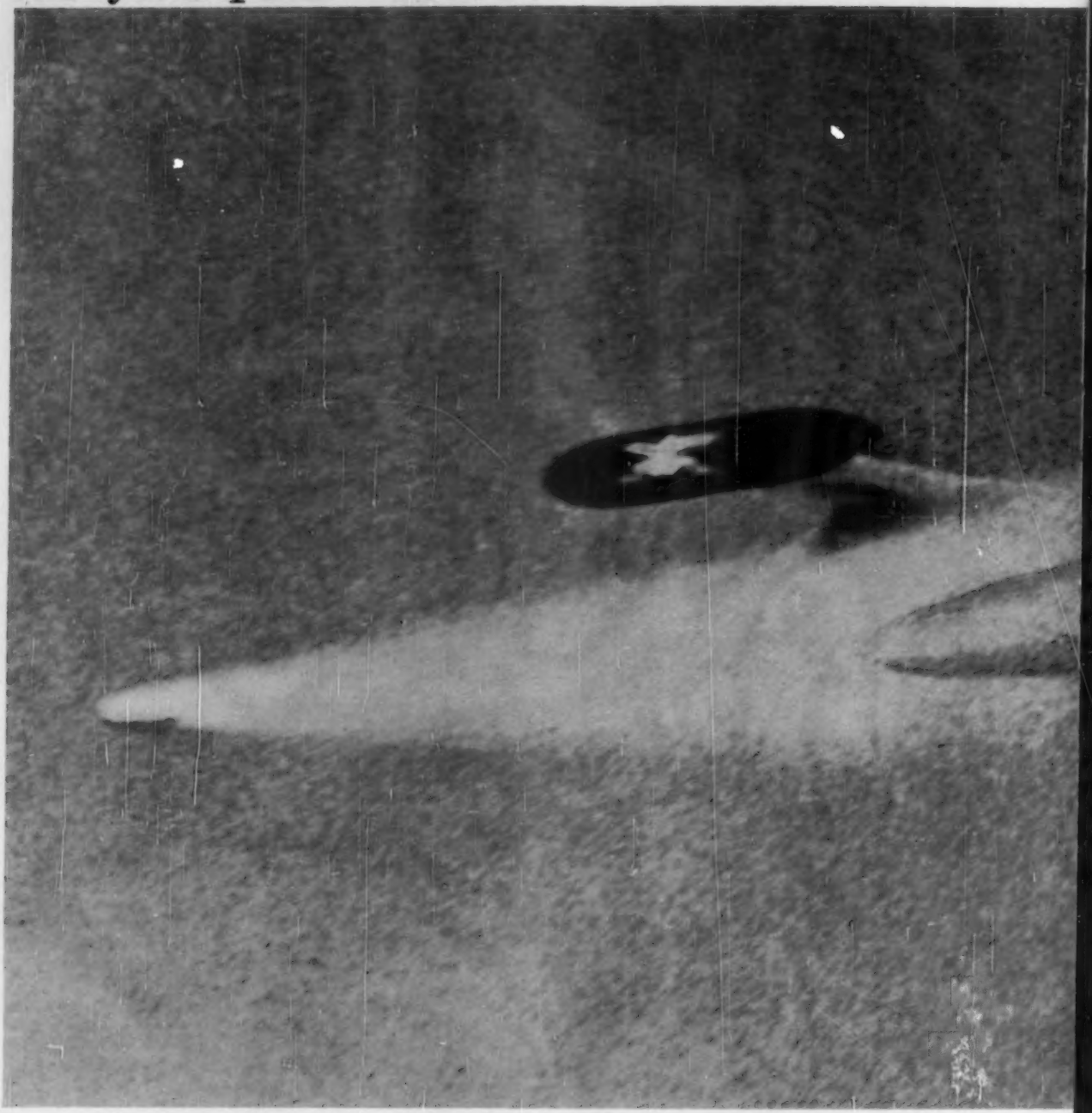


One-shot rocket blasts entire attacking fleet

Early last summer at Yucca Flats, Nevada, military observers saw the first demonstration of a new concept in defense weapons—the Douglas *Genie*...

Today this formidable nuclear missile is on operational duty with the Air Force—is the primary air-to-air defense missile in the U.S. arsenal.

The stubby *Genie* rocket is compact enough to be handled by a fast interceptor — yet can knock out an entire fleet of bombers with a single hit or a near miss. Designed primarily for use against high altitude jets, *Genie's* atomic warhead can be fired without radioactive fallout. It is thus usable against

ECONOMICAL cruise speed of jet transports is limited by sudden drag rise and boundary layer separation caused by weak shock (inset). Fully formed shock line is shown (left) with reverse flow behind it. Transport at right has bodies added to wing and fuselage in accordance with new NACA area rule. Bodies delay separation and raise economical cruise speed.

Industry Studies Transport Area Rule

By J. S. Butz, Jr.

Washington—Modified area rule developed by Richard Whitcomb of the National Advisory Committee for Aeronautics is attracting wide interest as a possible means of increasing the cruise speed of existing turbojet transports by 50 mph. It also is expected to improve their longitudinal stability characteristics.

Whitcomb's recommendations do not propose major structural changes but call for the addition of 10 nacelle-like bodies on the trailing edge of the wing and a large bulge on top of the fuselage just ahead of the wing root.

Performance benefits for current jet airliners attributed to these additions include:

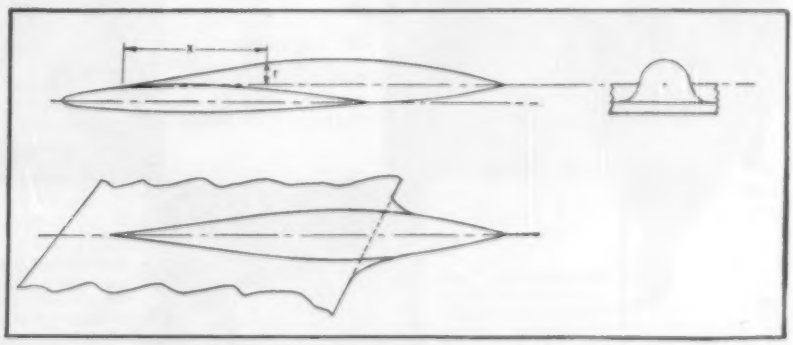
- **Increase in economical cruise speed** of about Mach .07 or around 50 mph. at 30,000 ft. with a wing sweep of 35 deg.
- **With a wing sweep of 45 deg.,** the added bodies become more efficient, and this economical speed increase is estimated to be Mach .14 or approximately 100 mph.
- **Significant improvement in variations** in pitching moment with lift above Mach 0.8 and at cruise lift coefficients. Pitch up is also greatly improved over the clean wing.

The new area rule work was conducted by the same Langley Laboratory group under Whitcomb that developed the first area rule several years ago. Experimental results of this work are reported in NACA Technical Notes 4290 and 4293 which were recently released.

Limited distribution of the preliminary data was made to airframe manufacturers last year and reported in AVIATION WEEK on August 12 (page 29).

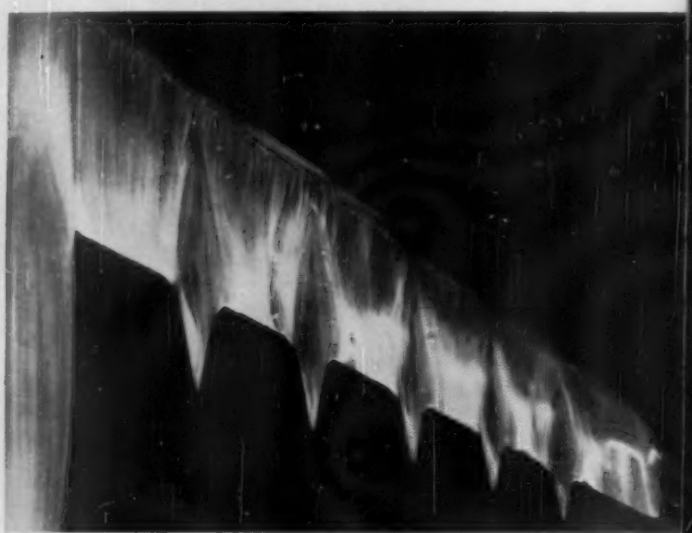
Whitcomb's new ideas came at a time of intense competition in the U. S. when jet transport designs were frozen and delivery dates of new aircraft were of paramount importance.

Apparently all the manufacturers and most of the airlines engaged in the race to produce and operate turbojet equipment are following Whitcomb's work with interest. Their degree of enthusi-



FOREBODY of wing additions slow supersonic air on upper wing surface and reduce shock wave strength, after portion of wing additions reduce drag of forebody.

SURFACE BOUNDARY layer flow is visualized during transonic tests at NACA Langley Laboratory. Wings on left have 35 deg. sweep and are similar to those on current high subsonic speed transports. Right hand pictures show same wings with best arrangement of Whitcomb's added bodies. Upper photos were taken at Mach 0.88, the middle ones at 0.90 and the lower photographs at Mach 0.92. The forward fuselage bulge was attached for all of these pictures.



BOUNDARY LAYER separation begins midway out on unmodified wing and is well developed at Mach 0.88. Fuselage addition delays separation on inboard sections. Flow separation occurs along light line. Behind this line the flow turns forward and outward which is typical of the low-energy boundary layer in a separated region on a swept wing. Added bodies eliminate separation up to Mach 0.90 and reduce it at higher speeds by weakening wing shock wave.

asm depends to some extent upon the importance of delivery dates to meet route competition and the difficulty and cost of modifying the aircraft.

As no security is tighter than proprietary secrecy, most industry discussion of applications of the new area rule is in very general terms. Opinion is generally that the second generation of turbojet transport is the most likely to use some of Whitcomb's suggestions. The length of time required to modify the aircraft scheduled for delivery during the next year or two is believed to delay their completion dates prohibitively.

Practical Application?

Even if delivery dates are of no concern, there is no certainty that the new area rule will find practical application. While every effort was made in the NACA work to design the additions for use on existing aircraft without major structural change, it was not suggested that such a general study could anticipate all of the major problems involved in modifying several types of jetliners.

Adding 10 bodies on a wing could change its flutter characteristics and interfere with its flap and lateral control systems. Other changes which might have to be made while increasing the cruise speed on a high subsonic aircraft by 50 to 100 mph. include changing the lip radius of the engine nacelles and the sweep or thickness of the stabilizing and control surfaces for best performance. Structural weight of the added bodies also would have to be weighed against their aerodynamic advantages.

In view of these and other considerations, which vary in seriousness with each design, it is probable that if Whitcomb's basic ideas are used they would be altered. For instance, the size, location and number of the added wing bodies would vary widely to accommodate a given set of wing problems.

It is known that one jet transport manufacturer has prepared a detailed modification proposal based on Whitcomb's suggestions, and it is now in the hands of the requesting airline. The manufacturer is pleased enough with the modification that a similar proposal is being prepared for wider circulation.

Fundamentally, there is considerable difference in purpose between Whitcomb's latest work and the original area rule even though both concepts involve some degree of smoothing out an aircraft's area distribution.

Shock Wave System

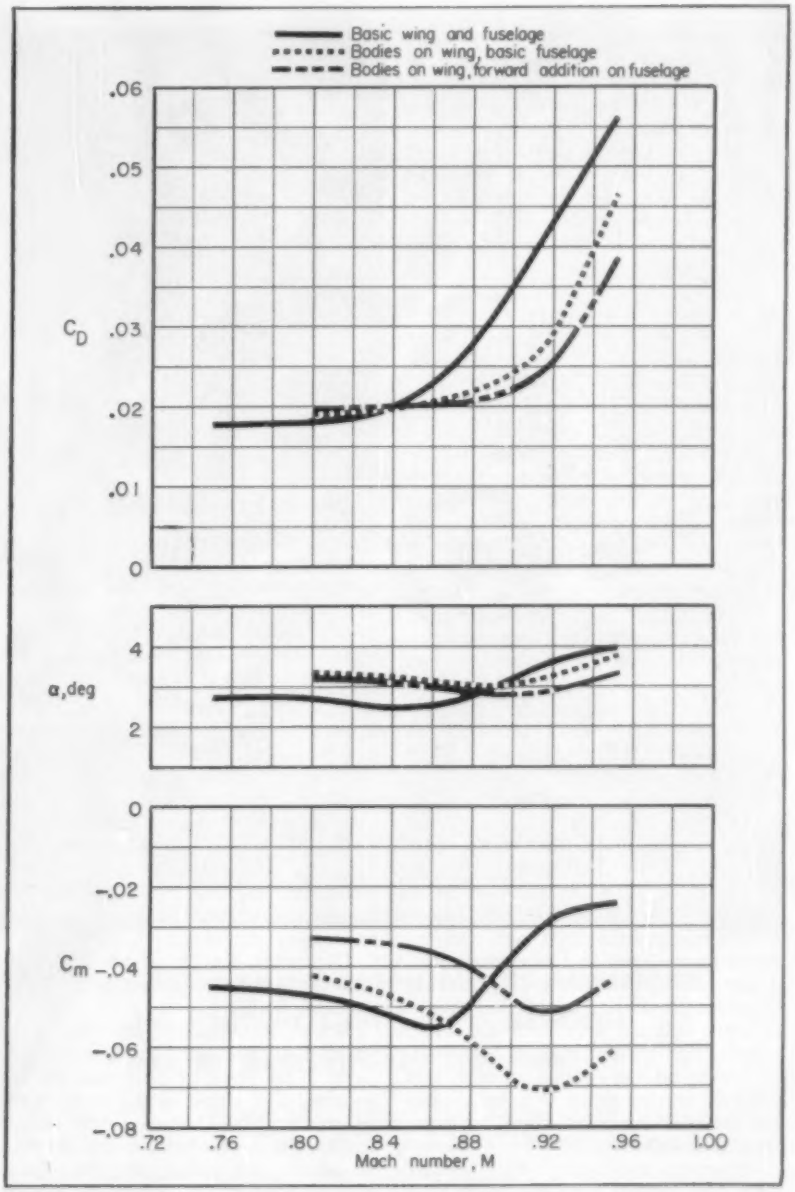
First area rule treated the strong, fully developed shock wave system that envelopes an aircraft at Mach 1 and raises its drag many times above the subsonic value. The very large drag and the strength of the sonic speed shock wave system were reduced primarily by adjusting the cross-sectional area so that it varied evenly from nose to tail. This resulted in the now-familiar "wasp-waist" fuselage shape which was indented to allow for the cross-sectional area of the wing.

A different problem inspired the new, modified area rule. It is the sudden increase in drag which usually occurs at about Mach 0.8 and builds up rapidly to a maximum around Mach 1.0. Main cause of the sudden drag rise on subsonic wings usually is a weak shock wave that forms on the wing around the point of maximum thickness.

This shock trips the boundary layer so that it separates and, in effect, gives the wing a large blunt base raising its drag. The boundary layer separation occurs in an erratic pattern, causing severe fluctuations in the center of lift on the wing and in the pitching moment of the aircraft. It also causes a significant loss of lift for a given angle of attack.

Economic Operation

Economical operation of a transport aircraft depends primarily upon the lift/drag ratio and the cruise speed. In the past, when lift drag ratios remained



TYPICAL wind tunnel data on the effect of Whitcomb's added bodies are shown above for a constant lift coefficient of 0.3. With both wing and fuselage additions in place, the drag rise Mach number is increased by 0.07; the angle of attack required to maintain constant lift remains almost constant, and longitudinal stability increases to a higher Mach number. Pitching moment variation with lift also is more favorable with the added bodies.

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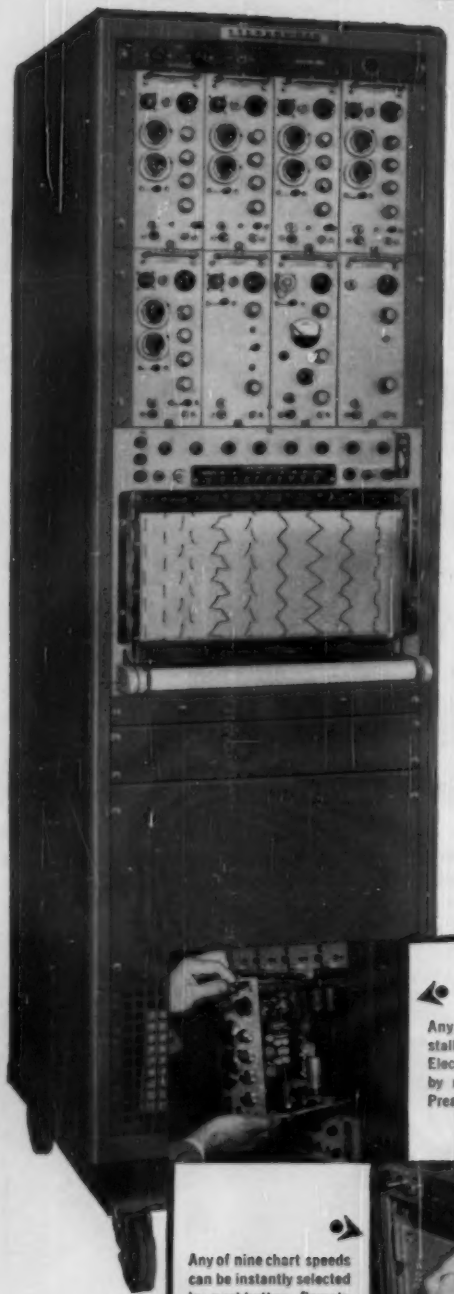

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fairly constant with speed, an increase in aircraft size or speed resulted in lower operating costs per seat-mile.

This is not true when transonic speeds are reached. Current turbojet transports are capable of flying into the transonic regime at Mach numbers above the drag rise, but economical operation is not possible much beyond this point because the lift/drag ratio drops off quickly.

For most turbojet transports now flying or that will be flying during the next year or so, the drag rise Mach number is about 0.8, or a speed of around 550 mph., at 30,000 ft. altitude. This means that, in normal use the aircraft would cruise at about 550 mph.

Whitcomb's modified area rule is valuable because it keeps the lift/drag ratio high at the same time that it allows an increase in cruise speed and lowers the operating cost. He believes that it will someday be economical for an aircraft to cruise at Mach 1.

Wind tunnel model—having roughly the same wing-fuselage characteristics as current U. S. turbojet transports—was used to experimentally verify the new area rule. The basic model wing had a 35 deg. sweep, an aspect ratio of 7.05, a taper ratio of 0.38 and was 13% thick at the root and 9% thick at the tip.

The first tests, reported in NACA report TN 4290, involved finding the proper shape and location of the fuselage bulge. Whitcomb started with the following known information and arbitrary restriction:

Area-ruling an aircraft not only reduced its transonic and supersonic drag, it also delayed the drag rise by reducing the strength of the initial shock wave over the inboard section of the wing; any fuselage shaping was to be accomplished by adding caps ahead of and/or behind the wing rather than by narrowing the cabin space and requiring major structural redesign.

However, area-ruling the fuselage with caps did not help the shock wave formation on the wing midsemispan. The boundary layer on the midsemispan was thicker than that on the inboard sections because of the spanwise flow on the swept wing, and it separated more quickly due to the interaction with a shock wave.

To improve this situation, Whitcomb cambered the cap on the upper forward section of the fuselage to improve its lift generating qualities. This not only increased the lift borne by the fuselage, it also increased the local angle of attack on the inboard wing sections and increased their lift.

This improvement in lift on the center span and fuselage allowed a reduction in the lift carried by the more critical midsemispan region and reduced the tendency of its boundary layer to separate.

New French Carrier

Dassault Etendard IVM navy jet fighter will operate from France's first postwar-built carrier Clemenceau. Model also shows Breguet 1050 Alize turboprop anti-submarine warfare aircraft and Vertol HUP-2 helicopter near island. Clemenceau is being completed at Brest Navy Yard.

Further study showed that only the upper forward fuselage cap had a large effect in reducing the strength of the shock on the inboard wing, so it was the only one retained. Unpublished experimental results also has shown that the lateral distribution of such a cap did not appreciably alter its effectiveness, so it was concentrated on top of fuselage to improve the structural picture.

The other NACA report TN 4293 deals with the design and function of the wing bodies.

Whitcomb reports that the wing bodies have two principal beneficial effects. They serve to decelerate the supersonic flow ahead of the shock wave on the wing and consequently reduce its strength. The bodies also act like boundary layer fences, and their local pressure fields greatly reduce the adverse outward flow of the boundary layer on a swept wing.

Theoretically, he says, the bodies weaken the shock because they effectively reduce the curvature of the wing chord near its maximum ordinate. The exact shape of the forebody to accomplish this was developed through a special extension of the area rule.

Several of the bodies are needed on each wing because their favorable effects do not extend over a wide range laterally around the drag rise Mach number. The inboard body is fairly far out on the span because of the action of the forward fuselage bulge. A number of body arrangements were tried by Whitcomb and five on each semispan proved to be the most effective.

The aft portion of the bodies serve no purpose other than to prevent separation of the forward part that does the work. The aft body is only long enough to give it a fineness ratio that will guarantee this function at the maximum Mach number.

Longitudinal pitchup of the model was greatly improved and, in some configurations, eliminated. This was primarily due to the reduction in flow separation at the wing tip resulting from decreasing the local shock strength and retardation of the spanwise flow. Most severe separation still occurs at the wing tip and Whitcomb believes that the favorable pitchup quality under these conditions could be due to the rearward movement of the separation at the wing tip which usually results in a smaller loss of lift or could be due to lift generated by the added bodies.

Whitcomb's tests included increasing the wing sweep to 40 deg. All of the beneficial effects of the added bodies were increased with this configuration. These favorable results have caused Whitcomb to extrapolate his data slightly and to predict that the improvement in drag rise Mach number could be 0.14 with a sweep of 45 deg. This could be an increase in economical cruise speed of about 100 mph.

He also believes that, because of the increasingly favorable action of the added bodies on pitchup as the wing sweep increases, that the pitchup limitations ordinarily restricting the use of high sweep angles will be essentially eliminated. The present reports do not indicate that Whitcomb has ceased to work at reducing transonic drag or increasing the drag rise Mach number.

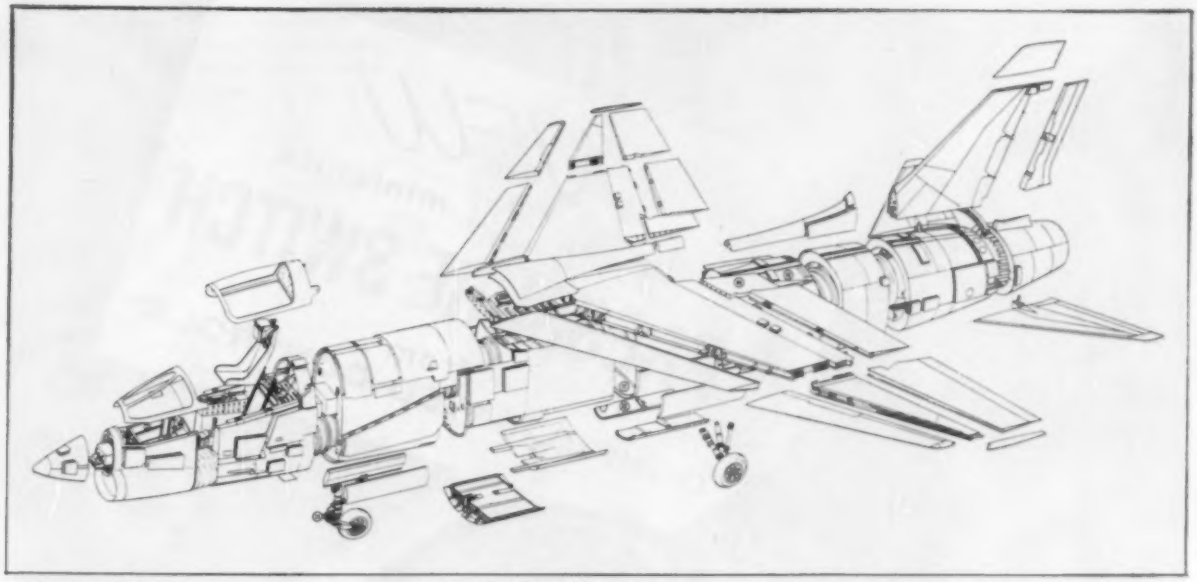
VTOL Research Aircraft Makes Tethered Takeoff

Short Brothers and Harland's S.C.1 VTOL research aircraft has made its first vertical takeoff in a tethering ring at Belfast. Company reports delta wing aircraft rose clear of the takeoff platform several times.

Performance and handling are being checked prior to full-scale hovering trials. Four of the aircraft's Rolls-Royce RB-108 jet engines provide power for vertical takeoff while a fifth is used for forward flight.

Engineers Get 5-8% Pay Hikes at Douglas

Douglas Aircraft Co. engineers' salaries will be increased a total of $2,225,000 annually under terms of a new agreement with the Southern California Professional Engineering Assn. Increases range from 5 to 8% depending on employe's classification. Engineers also will receive retroactive pay at 4% dating back to Jan. 6, 1958. Contract extends for two years and provides for a 3% increase in June, 1959.



SCHEMATIC drawing shows assembly of Chance Vought F8U-1. Complex magnesium castings form major part of the canopy framework.

Supersonic Carrier Fighters

same as the F8U-1. Improvement in speed puts the new fighter close to Mach 2.

Externally, the only changes are the addition of two low aspect ratio ventral fins on the aft fuselage and two airscoops for the afterburner cooling on the tail cone. These changes are being flight tested on two modified F8U-1s. First production models of the F8U-2, which will also have an improved fire control system and radar, will come off the line in September.

Big jump in the Crusader series came when the F8U-3 made its first flight. Although this new fighter looks very much like the earlier F8U models, it is actually a new design in many of the systems and concepts it employs.

F8U-3 is powered by a Pratt & Whitney J75 engine that develops about 17,500 lb. thrust without its afterburner and close to 26,000 lb. thrust with afterburning. With this kind of power, top speed of the new fighter is closer to Mach 3 than Mach 2. F8U-3 has two movable ventral fins which are horizontal in low speed flight, but which are extended downward nearly 90 deg. at high Mach numbers to improve stability.

Key to F8U-3 combat capability is a feature which neither Navy nor Chance Vought has commented on thus far. That is a rocket engine power package which will give fighter better climb and dash capabilities and will improve high altitude combat capability. Rocket engine was not on the first F8U-3 to fly.

The F8U-3 with its J75 engine is reported capable of staying aloft more than three hours without refueling, and this means that combat radius is close to 1,000 mi. This range is without external fuel stores. Although external fuel stores for the J75 engine could be added to increase range, they probably won't be considered necessary for the mission envisioned for the F8U-3.

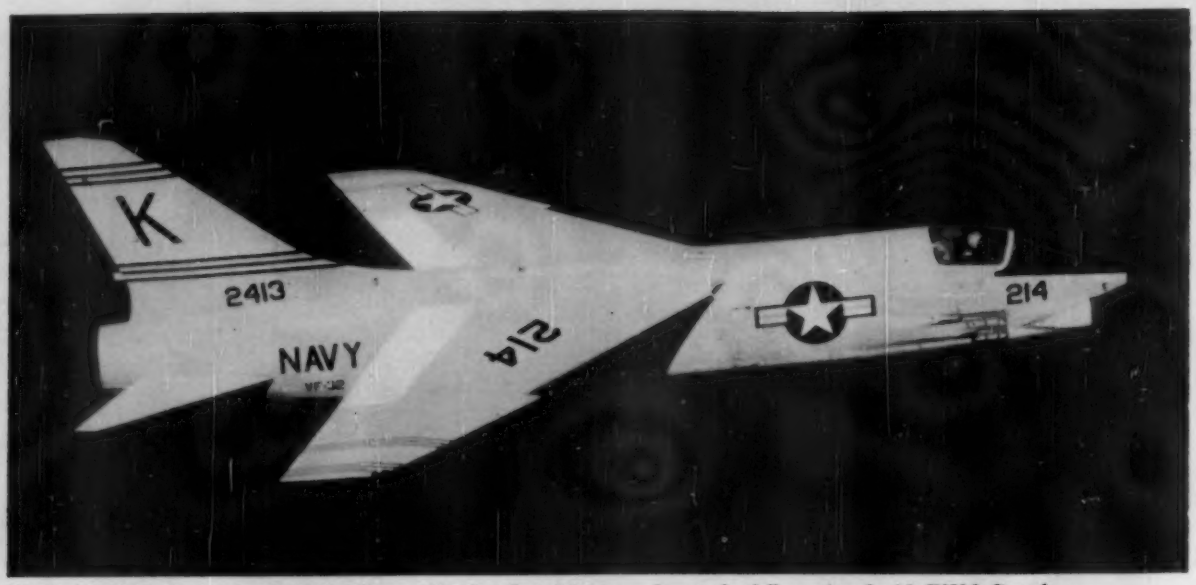
F8U-1s, on Chance Vought assembly line in Dallas, contain about 650 lb. of titanium.

Automatic Flight Controls

Another important advance in the F8U-3 is the extent to which its flight control system has been made automatic. The new system allows a pilot to hold such things as Mach number, rate of climb or altitude by pushing a button. Equipment to limit Gs and roll rate keeps the aircraft from exceeding allowable stresses and maneuvers.

A sharper nose, the ventral fins and a modified Ferri-type supersonic inlet with swept forward lip are the main visible changes in the F8U-3 over its predecessors. The F8U-3 is heavier and slightly larger than the F8U-1. Length is 58 ft. 8.8 in.; wingspan is 39 ft. 11.4 in. and height is 16 ft. 4.5 in.

Like the earlier Crusaders, the F8U-3 has a two-position wing to give it carrier landing capability. But unlike the earlier models, it also has a boundary



VF-32, Naval Air Station, Cecil Field, Fla., was the first fleet fighter squadron to be fully equipped with F8U-1 Crusaders.

F8U Design Provides Navy With Family of

By Craig Lewis

Dallas—Chance Vought Crusader design is currently providing the Navy with a supersonic series of operational carrier fighters. Crusader III, a new fighter in the series, has just moved into the flight test stage.

Chance Vought is currently producing the F8U-1 day fighter and the F8U-1P photoplane, and these aircraft are in squadron service with the Atlantic and Pacific Fleets. A faster Crusader, the F8U-2, is now in prototype flight test. During the year it will be in production with the F8U-1 and F8U-1P.

F8U-3 Flies

Crusader III, the F8U-3, made its first flight June 2 (AW June 9, p. 21) and has entered a flight test program which will eventually give the Navy an all-weather fighter that can operate at speeds well past Mach 2. Navy has ordered 18 F8U-3s for its test program, and a decision will be made between this latest Crusader and the McDonnell F4H (AW June 2, p. 21).

Current mainstay of the Crusader series is the F8U-1. Powered by a Pratt & Whitney J57 engine, this day fighter can operate at altitudes over 50,000 ft. and at speeds in excess of Mach 1.5.

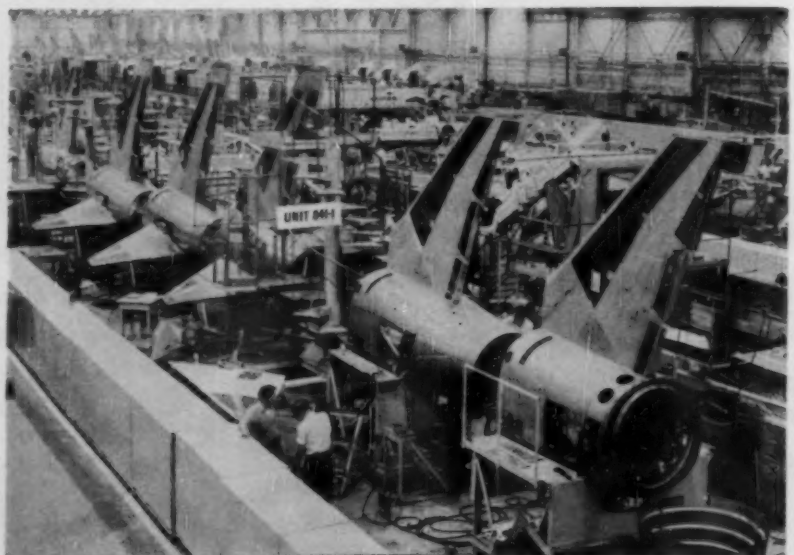
It has long range, considering its power, due to a large internal fuel capacity. F8U-1 uses a unique two-position wing to give it carrier landing capability.

Fighter is armed with cannon, rockets and missiles. It has four 20 mm. cannon and a pack containing 32 rockets. It also carries Sidewinder air-to-air missiles in racks mounted on the sides of its fuselage.

Crusader set a national speed record two years ago when it won the Thompson Trophy. Record mark of 1,015 mph. is under the top speed capability of the F8U-1. Navy and Chance Vought also won the 1957 Collier Trophy for the F8U-1 design.

Photoplane version of the Crusader is very similar to the F8U-1 in size and performance, although it has some area rule treatment of the wing to compensate for camera installations. F8U-1P held the transcontinental speed record last summer after it made a supersonic dash from Los Angeles to New York in 3 hr. 23 min.

Successor to the F8U-1 on the Chance Vought production line will be the F8U-2 powered by an advanced version of the J57. With its more powerful engine, F8U-2 offers more speed and higher altitude performance in an airplane that weighs about the



CIRCULAR portions of these F8U-1 Crusader tail sections are made entirely from titanium.

layer control system which blows air over the flaps to improve lift and control.

Crusader III is armed with missiles. It can carry the Sparrow III, the Sidewinder or combinations of the two. It may also be adapted to carry special weapons, electrical intelligence equipment or photo reconnaissance equipment.

Chance Vought draws considerable pride from the tight schedules under which these Crusaders were developed. The F8U-1 made its first flight 22 months after it won a design award in May, 1953, and only 46 months elapsed between the time the company learned that it had won the contract and the day it began making fleet deliveries.

Company also points out that it built and flew the F8U-3 in less than 23 months, three months ahead of contract schedule.

The Crusader story starts in September, 1952, when the Navy asked for design proposals for a day fighter that could exceed Mach 1 in level flight. Chance Vought was one of eight competitors, and its proposal won the contract in May, 1953.

Wind Tunnel Tests

Chance Vought did 800 hr. of testing in low-speed, transonic and supersonic wind tunnels before the design contract was awarded, and in the later stages of development, Navy and National Advisory Committee for Aeronautics support in obtaining hard-to-get tunnel time helped considerably in meeting the design schedule.

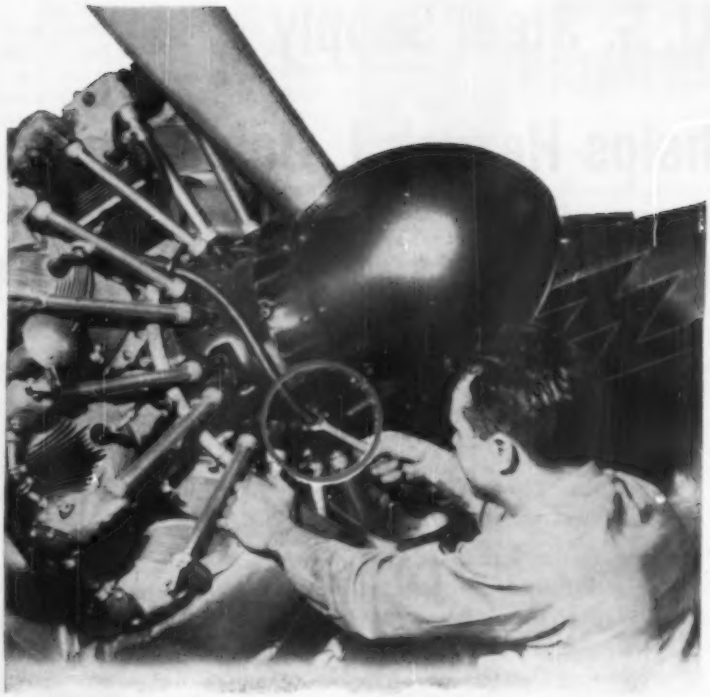
In addition, Crusader models were fired at NACA's Wallops Island facility to get actual flight data, and NACA developed free-flight power models for use in wind tunnel testing.

First flight of the XF8U-1 was made by Chief Test Pilot John Konrad at Edwards AFB in March, 1955, and the airplane went past Mach 1 on this initial flight. After test programs were completed, F8U-1 started a Fleet Indoctrination Program in January, 1957. This program was completed in 53 days, despite bad weather. During the program, the Crusaders made 415 flights and logged 603 hr.

First production delivery was made in March, 1957, to VF-32, which was training at Cecil Field, Fla. Since then, the F8U-1 has gone into squadron service with the Atlantic and Pacific fleets.

Key element in the Crusader design is its unusual two-position wing. In normal flight position, it is a fairly conventional supersonic layout, but in the tilted position, it gives the fighter the necessary approach speeds and cockpit visibility for carrier landings.

This variable incidence wing answers the problem of good visibility with low canopy drag in a supersonic airplane. Without the tilted wing, the pilot



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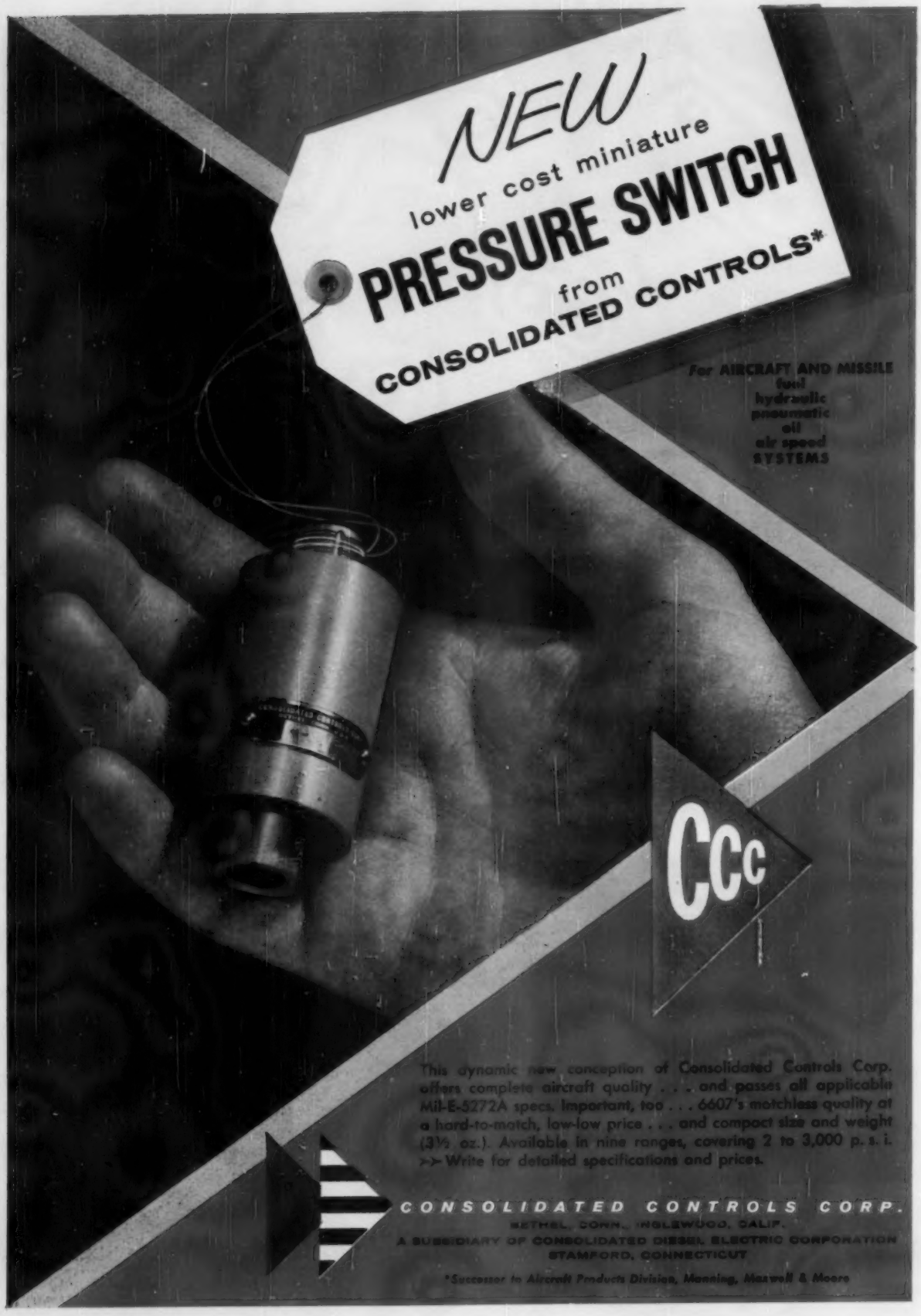
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would have to sit higher in order to see the carrier deck and landing signal officer because of the high attack angle of the wing, and the attached fuselage, at approach speeds.

Good visibility under these conditions would require a large canopy. Chance Vought found that the required canopy would cause about 35% of fuselage drag at supersonic speeds, so the engineers turned to other solutions. Ideas investigated included elevating the canopy and seat on landing, and tilting the nose section downward.

None of these ideas seemed practical, and designers decided the variable wing was the best way to keep the fuselage with its low drag canopy relatively level in the landing configuration. High wing layout was chosen because it is simpler to raise the leading edge. In a low wing configuration, it would be necessary to cut a notch in the fuselage to raise the leading edge or face the power problems of forcing the trailing edge down into the airstream to change wing incidence. Low wing could also cause pitchup problems with the horizontal tail at transonic speeds.

High variable wing also put the fuselage closer to the deck, permitting a simpler, lighter landing gear design and making it possible to perform all normal line maintenance without using work stands.

Wing is a Chance Vought design using a modified standard NACA high speed airfoil. It has a large sweep at the quarter chord and has a sawtooth leading edge step which keeps the airflow in the outer wing area attached to the wing and eliminates the need for fences. Thickness chord ratio varies from 5.5 deg. to 6 deg. over the 35 ft. 8 in. wing span. F8U-1 is 54 ft. 3 in. long and the tail is 15 ft. 9 in. high.

Tilting the wing on landing gives the Crusader a relatively low landing speed, yet keeps the fuselage at an angle of about 5.5 deg., rather than the 12.5 deg. required with the wing in the low position. Landing with the wing in the low position also requires higher approach speed.

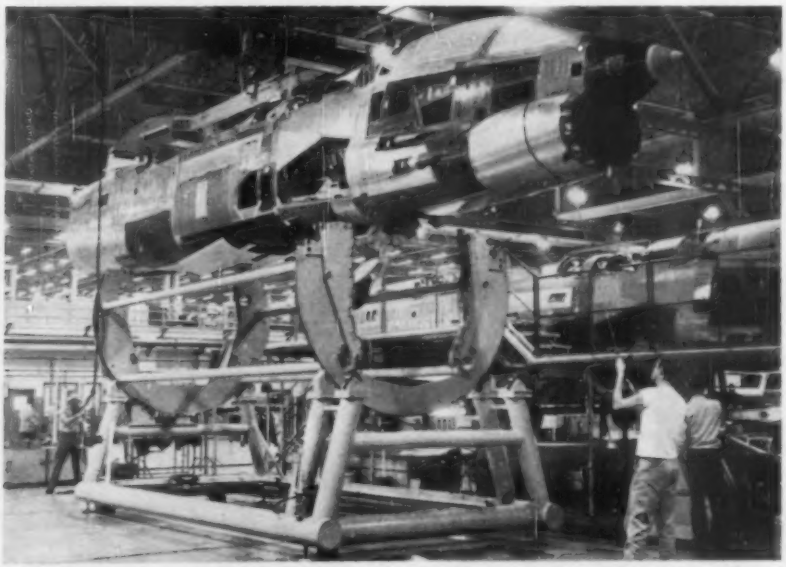
When the wing is tilted for landing, ailerons and flaps droop 20 deg., and the leading edge droops about 28 deg. The horizontal tail repositions about 5 deg. to compensate for trim change.

Boundary Layer Control

At the time the F8U-1 was designed, boundary layer control and other high lift devices were not very highly developed, and their disadvantages discouraged Chance Vought from using them. But the company has kept in touch with these techniques and has been testing a boundary layer control system on an F8U-1. Tests indicate this system allows the Crusader to land with 4 deg. less wing incidence than is normally used.

An obvious outgrowth of this work is the boundary layer control system on the F8U-3. The added lift of this system may allow the F8U-3 to land with less wing incidence, but it doesn't replace the two-position wing approach to the carrier landing problem.

Commenting on the use of the variable incidence wing approach to the supersonic carrier fighter landing problem, Chief Engineer J. R. Clark says this wing design is the best way to solve the problem with a swept wing



CRUSADER fuselage is rolled over on production line to dislodge bits of metal. Open access doors on fuselage let pieces of metal fall out during rotation. Contour pads made of fire hose are attached for forward part of rotation assembly fixture.

PUMP PRIMERS

by

Arthur A. Nichols

Gerotor multiple element oil and scavenge pumps find increasing application as temperatures and pressures rise in the newer jet engines.

The rather unusual qualities of the Gerotor pump which have kept it intimately associated with aircraft pumping applications from the days of the earliest superchargers for reciprocating engines, can best be summed up as *inherent adaptability* and *high reliability.*

Fig. 1
Multiple Element Lube and Scavenge Pump

• **Engineers find the Gerotor pump most attractive** because there are several convenient variables that can be adjusted to meet the application requirements: Gerotor *diameter* which governs the area of the pumping chamber, Gerotor *thickness*, which, taken with area, determines *unit volume* per revolution and *RPM*. Thus, it is possible to vary the diameter, length and speed of the pump elements to secure wanted capacity. In addition, the porting of this type of pump is completely flexible in location, making for ease of fitting adaptability to the available space and geometry of the engine structure.

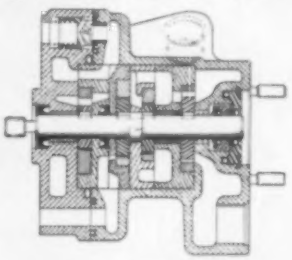


Fig. 2

• **The two parts which make up a Gerotor element are mounted on a single, common shaft** and this structure permits stacking a number of pumping elements along the shaft in a common housing. By providing each set with a separate, fluid tight compartment and inlet and discharge ports, lubricating, scavenging and booster services having the same or different capacity requirements can be combined in a single pump with maximum efficiency. (See Fig. 2).

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aircraft. He also points out that boundary layer techniques can be useful, but he sees them complementing rather than replacing the tilted wing approach.

Flight testing of the Crusader wing design indicated that small flaps should be added between the aileron and the fuselage. This move provided a better attitude with a lower wing incidence and improved flying qualities in the approach condition. Wing incidence was reduced from 9 deg. to 7 deg.

Wing Actuation

Wing is hinged at the rear and is raised by an Aeroproducts hydraulic actuator on the right front side. Actuator is designed to actuate loads of about 5,400 lb. extension and 1,700 lb. retraction at 3,000 psi. hydraulic pressure. Its retracted length is 34 in., stroke is 17.5 in., diameter 3.5 in. and weight is about 30 lb. Double screw jacks raise the F8U-3 wing.

F8U-1 wing actuator is operated in an emergency from pneumatic pressure stored in air bottles. Unit freezes the wing with a clutch-type lock in any position where there is a power failure. And when the wing is down, the pilots lock it there manually to guard against inadvertent extension.

High wing arrangement permitted designers to use a single wing structure and helped them solve their range capabilities, but without the penalties involved in hanging the usual auxiliary tanks on the outside of the airplane.

The answer to the problem lies in the F8U-1's one-piece center section wing design which in turn permitted a simple lightweight wing structure embodying a straightforward integral wing tank design.

Success of this approach is indicated by the fact that at least one Crusader has stayed in the air for 4 hr. without refueling. If a pilot has to make a landing soon after takeoff, he can lighten the airplane by dumping fuel out of the wing. Crusader is also equipped with a fuselage-mounted retractable probe for air refueling.

The wing integral fuel tank is sealed in the wing subassembly operation after the two stubs are joined and the sculptured skins installed. Sealant is injected into a continuous groove, and there is no internal access to the fuel cavity during or after the sealing.

Development of the Crusader series has depended to a large extent on development of the J57 engine. XF8U-1 had the J57-P11, and the first few dozen production models were equipped with the J57-P12. Current production F8U-1s and F8U-1Ps get the J57-P4A, which is in the 16,000 lb. thrust class with afterburning. Now the F8U-2 will have the 17,000 lb. class thrust of the J57-P16 and its afterburner.

As producer of both the F7U and F8U, Chance Vought has had experience with both single and twin turbojet configurations. Engineers conclude that a single engine is the best way to get the highest thrust in the smallest, lightest airplane package. But that doesn't bar the dual powerplant approach.

Although Chance Vought hasn't discussed it, the use of a rocket engine on the F8U-3 is obviously a return to the dual powerplant approach, but in a somewhat different way. The very powerful J75 engine provides plenty of thrust for ordinary flight regimes, and obviously a rocket motor is needed only for dash capability and short term high altitude flight. Thus the rocket will provide a lower proportion of total thrust than it does in such designs as the English Saunders-Roe SR.53 and some other dual powerplant aircraft.

Rocket Motor

Rocket motor will be supplied by North American Aviation's Rocketdyne Division. The Rocketdyne engine was chosen over a Reaction Motors design that was reportedly more sophisticated but would have taken more money and time to develop. Chance Vought is developing a test facility for rocket engines at its plant here.

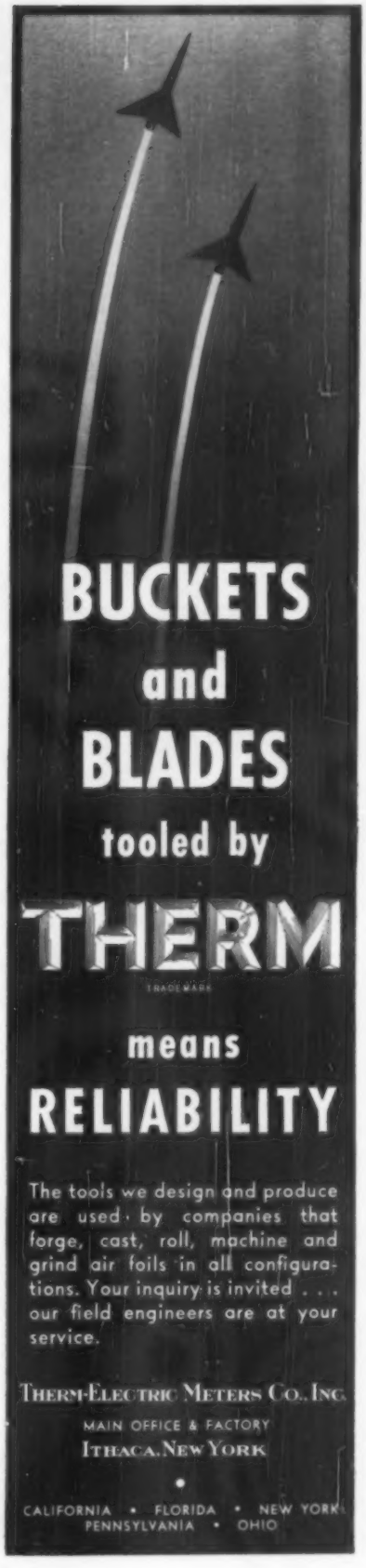
Shape of the F8U-1 fuselage was dictated by engine size and ducting. And the choice of a nose duct meant a deep fuselage. Lyman G. Josephs, Chance Vought F8U project engineer in design and development period, points out that, while the area rule principles were known at the time the Crusader was designed, there is no coking treatment on the airplane's fuselage.

There is a more subtle application of the area rule, however. In preliminary design, engineers plotted the airplane's dimensions and made sure that the area vs. length curve was smooth all the way back. Josephs said that no coking was applied because the amount the fuselage could be indented wouldn't have done enough good to make it worthwhile.

On the other hand, the F8U-1P made use of the latest area rule data in its design. It was bulged at the shoulders across the top of the fuselage forward of the wing. This bulge adjusted for the flat area under the forward fuselage to accommodate cameras. And it also provided space for equipment displaced in the lower fuselage by camera gear.

This treatment improved performance in the transonic area, although F8U-1P maximum speed is a trifle lower than that of the F8U-1.

Shoulder bulge compensated for the flat camera area and kept the plotted curve smooth. Some thought was given to bulging the rear fuselage to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make that part of the curve smooth and symmetrical, but wind tunnel tests showed little gain. So the photoplane is identical with the F8U-1 aft of the shoulder bulge.

Air intake presented no major problems, although at the time it was a unique treatment. There were some detail design problems in the shape of the duct and the nose section ahead of it. Nose had to be designed so that the oblique shock wave it creates would modify the airstream entering the intake to the correct degree.

Flight control on the Crusader is handled with a power control system on all three axes which incorporates artificial feel. The system is hydraulically powered and has three independent hydraulic systems. Longitudinal feel comes from a centering spring and bobweights, and directional lateral feel comes from the centering springs only.

Directional stiffening and damping is accomplished through a stabilization system. Laterally, the job is done with a roll damper.

Crusader has an all-a.c. electrical system. Chance Vought decided to use only alternating current because it looked like a more reliable system, especially at altitude. Also, it saved about 250 lb. over the weight of a combination a.c. and d.c. system, and elimination of many circuit breakers contributed to an uncluttered cockpit.

For air starts, a Marquardt ram air turbine unit, which can be used up to 725 kt., is moved into the airstream to generate auxiliary power. It supplies 2.5 kva. of a.c. power, 10 amp. of d.c., and 3,000 psi. of hydraulic power. For starting its engine on the ground, the F8U-1 needs a ground d.c. source.

To simplify production and make maintenance easier, much of the fighter's wiring is done in compact, removable units. Bundles of wires running from the cockpit to the two-position wing, the engine compartment and the tail section are put together on an assembly board as a single unit.

This board is checked out with an electrical simulator, and the entire unit is lowered into a channel on either side of the midsection.

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Main cabling is along the top longeron in the fuselage for easy access, and extensive use is made of the package system concept for hydraulic, control and other systems. Horizontal tail power control package, for instance, includes the power cylinder, valves and feedback mechanism. A replacement package can be installed by disconnecting less than a dozen bolts and hydraulic connections.

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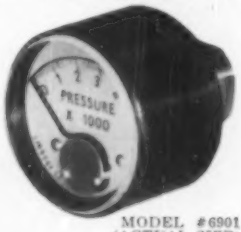

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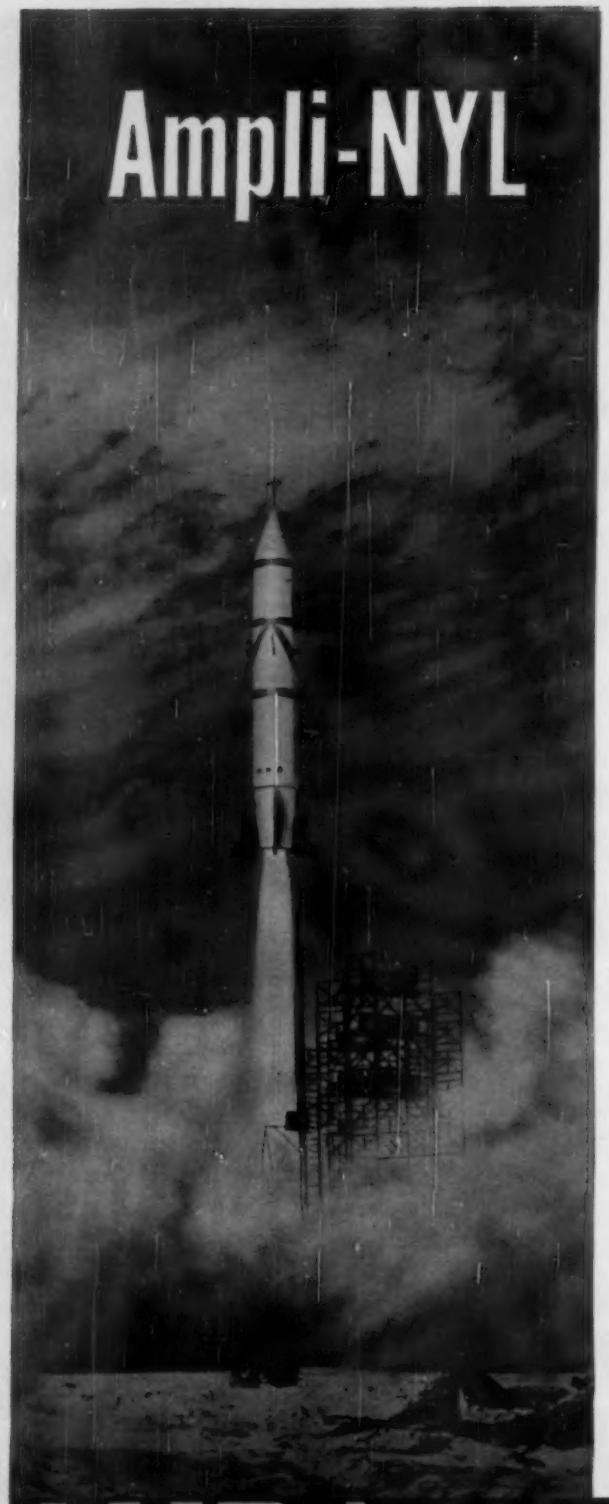

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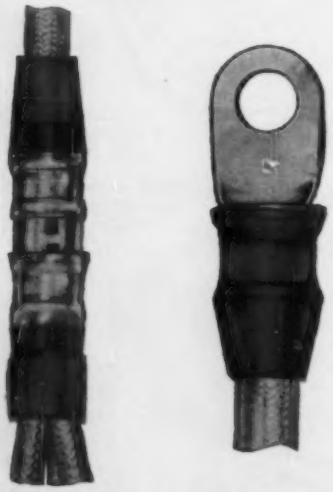

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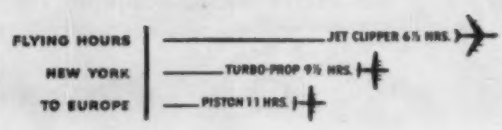

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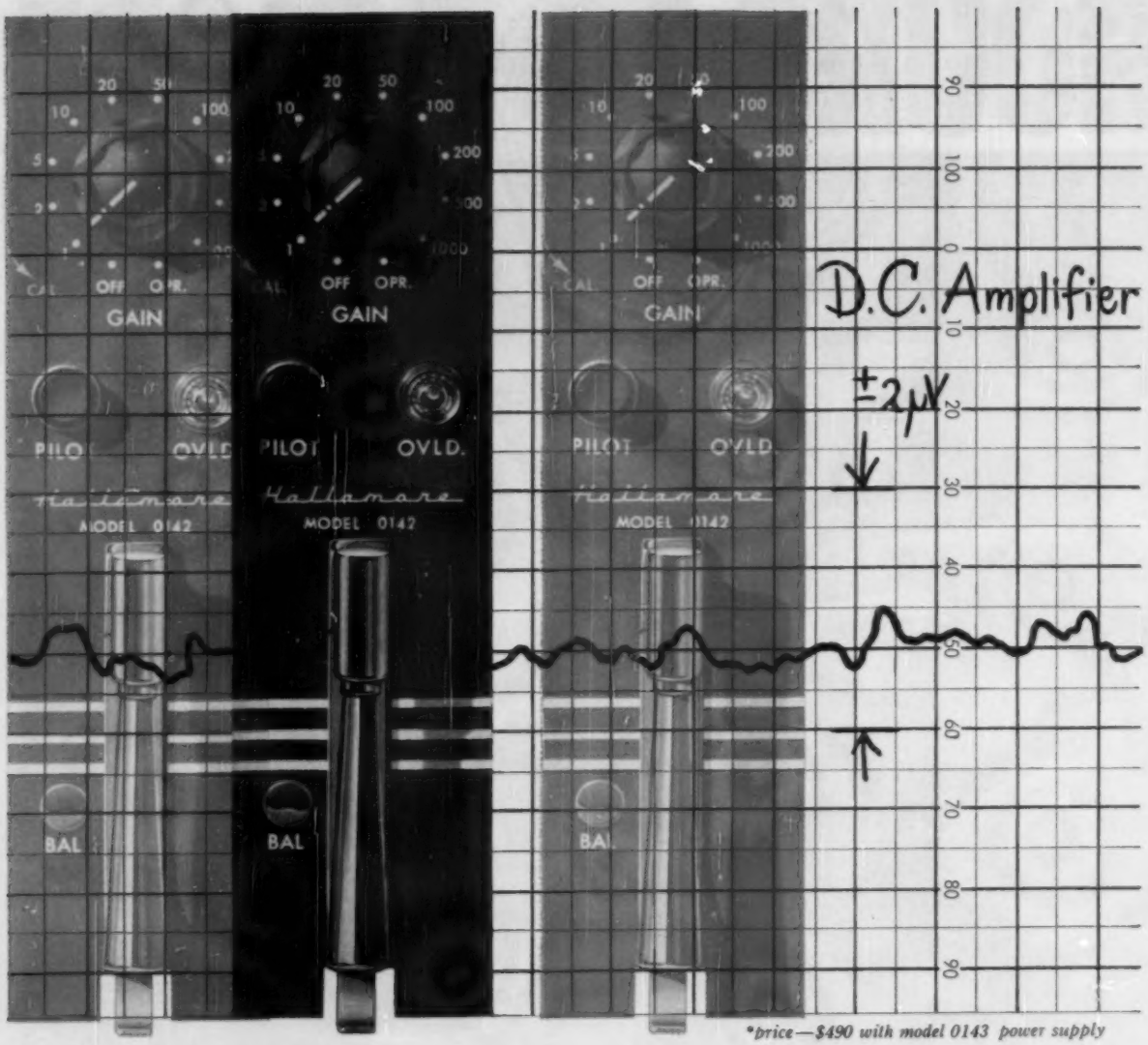

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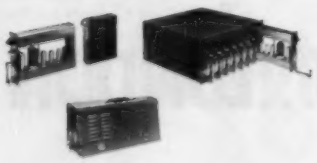

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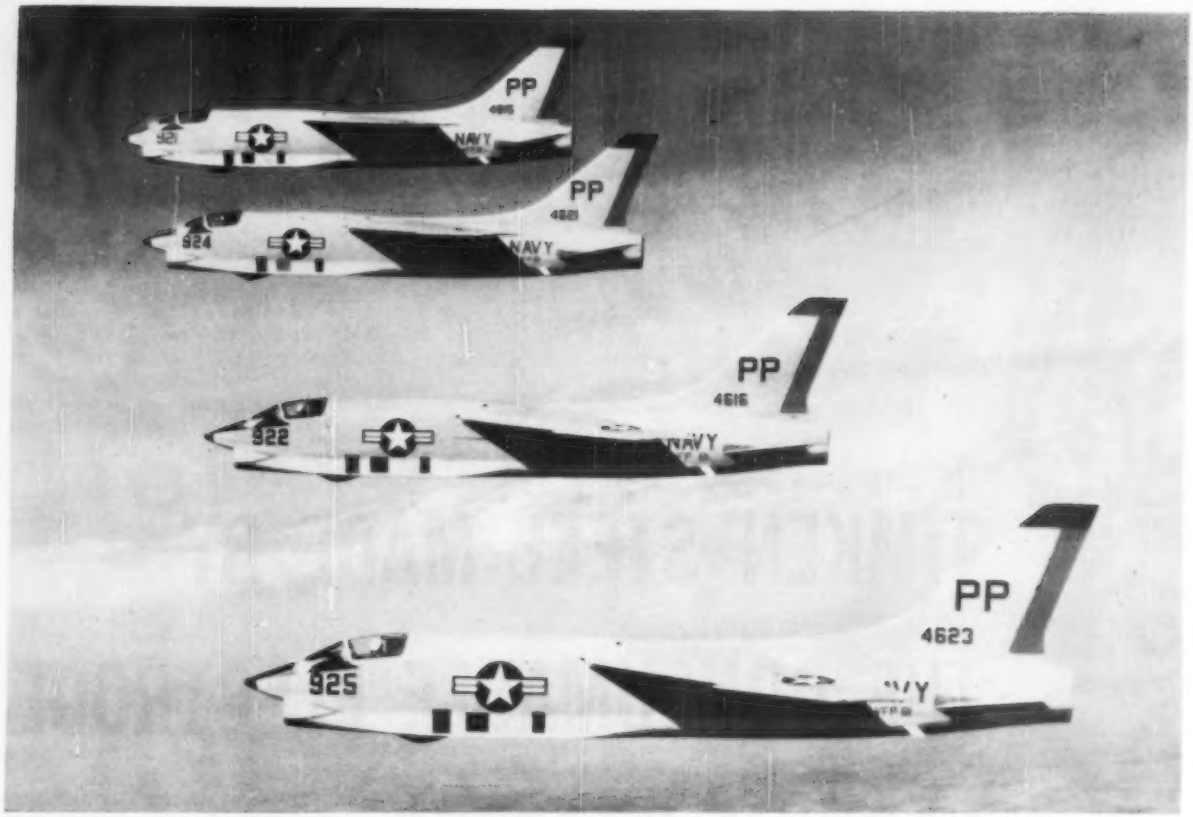

VFP-61 is first Navy photo-reconnaissance squadron on the West Coast to use Chance Vought F8U-1Ps (note fuselage camera bays).

wing was the fact that a smaller canopy could be used, and it could have a simpler, lighter structure and actuator. Canopy is operated manually and is counterbalanced with an air spring. With this and other savings, Chance Vought estimates the F8U-1 wing concept saved about 300 lb.

Crusader ejection seat is a Chance Vought design based on the A4D seat design concept. It is operated by a two-stage face curtain, and if the canopy jams, it is light enough that the seat can be blown through it. System includes automatic seat belt separation and parachute release.

This Crusader ejection seat, which weighs 30 lb., was further developed as a low altitude escape system, and it is good in the 25 to 50 ft. area.

Crusader's gross takeoff weight of about 27,000 lb. makes it a relatively light airplane for its capability. Chance Vought engineers say it was designed for light weight from the beginning and that success in this field is a "matter of wanting to do it."

Structure of the F8U-1 was designed on the optimistic side, as far as weight was concerned, with an eye to making corrections in the static test stage.

Considerable weight was saved by widespread use of castings. There are 275 magnesium sand castings in the airplane, and closer tolerances and precise casting permit these and other castings to be installed with only a hole drilling operation.

This approach not only saves weight, but it saves machining operations and assembly of smaller pieces.

Complex castings are used in such places as the canopy framework. Four magnesium castings form the major part of the framework, and two more castings form the windshield frame.

Precision steel castings are also used. There are about 35 different castings in the airframe, most of them heat-treated to maximum tensile strength. Another 25 different steel castings are used for special support equipment.

Titanium Use

There is about 650 lb. of titanium in the Crusader, and 25% of its outer skin is magnesium plate. Use of titanium saved about 250 lb. It was used mainly in the aft area where the afterburner created heating problems.

Chance Vought had to do some pioneering with titanium in order to bring it to the point where it was practical to use in a production operation. A special group was set up to study the problem. High hydrogen content was traced as the primary cause of cracking problems, and vacuum annealing proved the best way of removing excess hydrogen. Procedures were set up to process sheet stock and cut parts, and titanium producers were asked to cut the hydrogen content of the raw material.

A further weight saving contributed by the high wing was the relatively light and simple landing gear permissible because the fuselage is close to the deck. A light, fully retractable arresting gear design was also a benefit of the high, two-position wing.

Chance Vought set the weight and geometry of the landing gear, and Menasco designed and built it. Chance Vought engineers think it is the lightest ever designed.

Crusader was tooled and designed for high volume production, and producibility was designed into the airplane from the beginning, rather than being adapted after the experimental period. As a result, all of the major features of the production F8U-1 are the same as the experimental model.

Along with design work on packaging, castings and other aids to simple production, Chance Vought manufacturing people developed jigs, fixtures and workstands as the airplane design advanced. Scale models of these facilities and of the Crusader were made, and a miniature manufacturing area was set up to determine in advance the most efficient methods of moving the fighter through the production process and to eliminate bottlenecks.

Evidence Hints Pilot Cut SR.53 Throttles

London—Although loss of the Saunders-Roe SR.53 is still under investigation, it is believed that the pilot, Squadron Leader John Booth, cut the throttles late in an attempt to abandon takeoff. Earlier reports stated the engine stopped burning or cut out.

The aircraft never became airborne and ran through the overshoot with wheels down and anti-spin tail chute fully streamed. No other tail chute was fitted. Difficulties of keeping the high speed machine straight after it had gone through the overshoot would account for the collision path, a company spokesman said.

The pilot's only radio comment was "panic stations" which was the agreed message to control if the pilot intended to abandon the takeoff and would need towing assistance home.

AVIATION WEEK was told that there had been no previous case of engine failure at takeoff. It is possible that the late decision to abandon the takeoff was associated with high engine temperature indications or fire warnings, but factors not associated with the powerplant could have been involved.

The fact that the pilot did not retract the undercarriage was not considered surprising. According to a spokesman for Saunders-Roe, it is debatable whether raising the undercarriage would have helped. With wheels down the pilot retained cross country steerage, and wheel and drag chute braking remained effective. On its belly the increased drag of such a clean aircraft would not compensate for the complete loss of steerage and control and, at the speeds involved, the certainty of gyration, the spokesman said.

Takeoff and climb in the SR.53 can be made with both turbojet and rocket engine, or takeoff can be made with turbojet alone, the rocket engine being cut in after the aircraft is airborne (AW Dec. 23, p. 60).

Nuclear Reactor Started For Lockheed Test Unit

First of two atomic reactors slated for use in Lockheed's nuclear test facility was started by General Electric's Atomic Power Equipment Department, San Jose, Calif. Lockheed is doing development work on an airframe for nuclear aircraft at its Dawsonville, Ga., nuclear test facility (AW June 2, p. 51).

Critical Experiment Reactor (CER) will be used principally for checking out core configurations of the Radiation Effects Reactor (RER), the second reactor that GE is furnishing Lockheed. RER will determine how well materials can withstand nuclear radiation.

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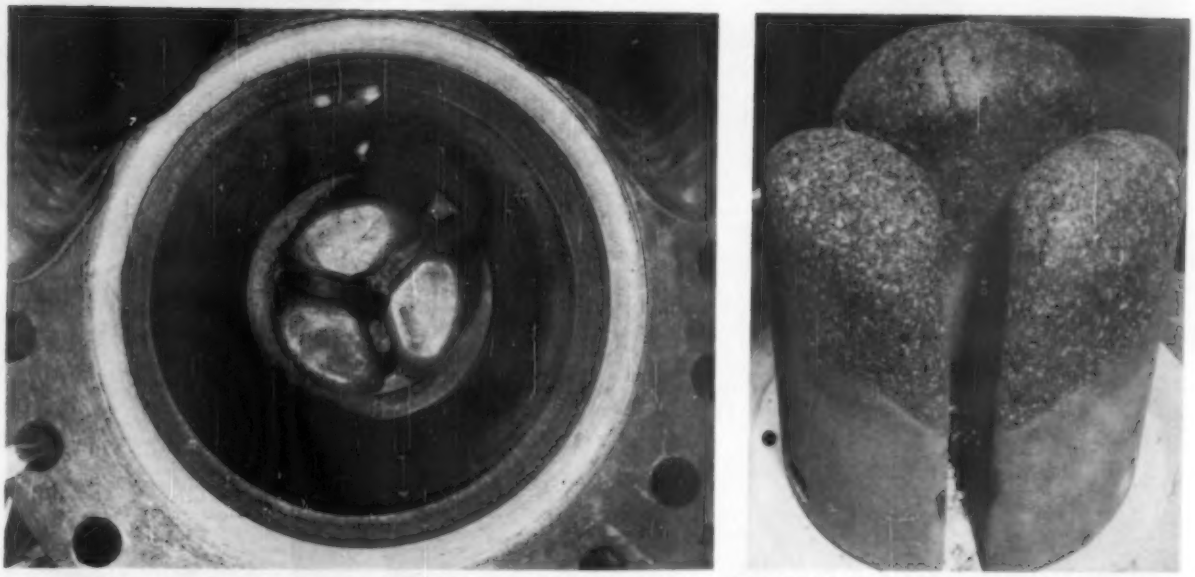


WITH top off, General Electric's air arc chamber (left) is prepared for a run. Steel wool is placed between three center electrodes to aid initial arcing. Fourth electrode, a large graphite sleeve, lines the chamber and is grounded. After a run, center electrodes are removed (right), showing the effects of the high intensity arc. Steel wool has been consumed. Maximum arcing time has been 15 sec.

Air Arc Simulates Re-Entry Problems

Philadelphia—Newest addition to General Electric's arsenal of space research tools is a large air arc capable of generating plasmas with temperatures twice that of the sun's surface.

Approximately four times larger than any previous General Electric arc, the new unit, a three-phase a.c. model, consumes electricity at the rate of 15,000 kw.—equivalent to the amount of power flowing into 5,400,000 average homes.

The arc is located at the company's Switchgear Department, one of the few facilities capable of generating the current required to run the unit.

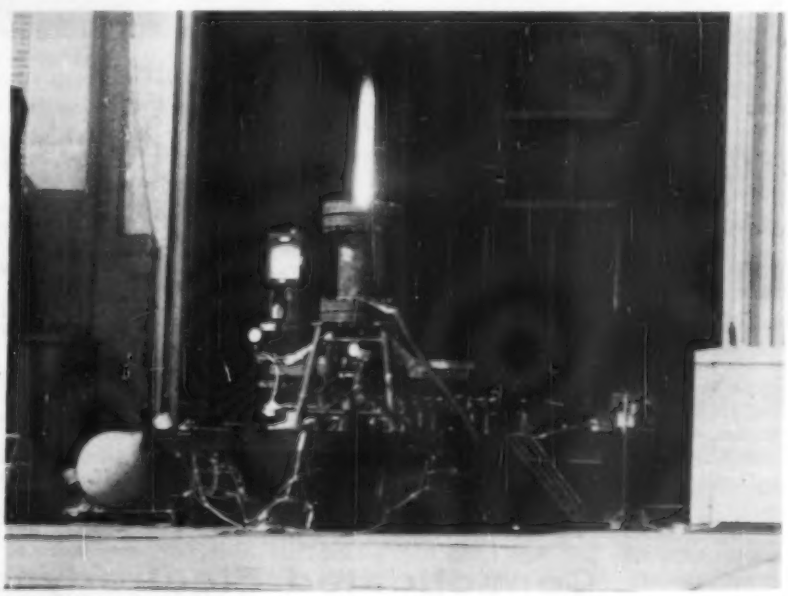
Like other arcs, the new unit will be used by scientists and engineers of General Electric's Aerosciences Laboratory to study the effect of extremely high temperatures on new materials and designs. Primary interest, of course, stems from the company's work on the re-entry problem. The large size of the new unit, says George F. Metcalf, general manager of General Electric's Missile and Ordnance Systems Department, will enable the scientists to use "more nearly full-scale models of re-entry vehicles" and to attain a closer simulation of actual flight conditions at speeds Mach 12-25.

In addition, General Electric scientists hope to learn more about ionic propulsion methods from studies of the arc.

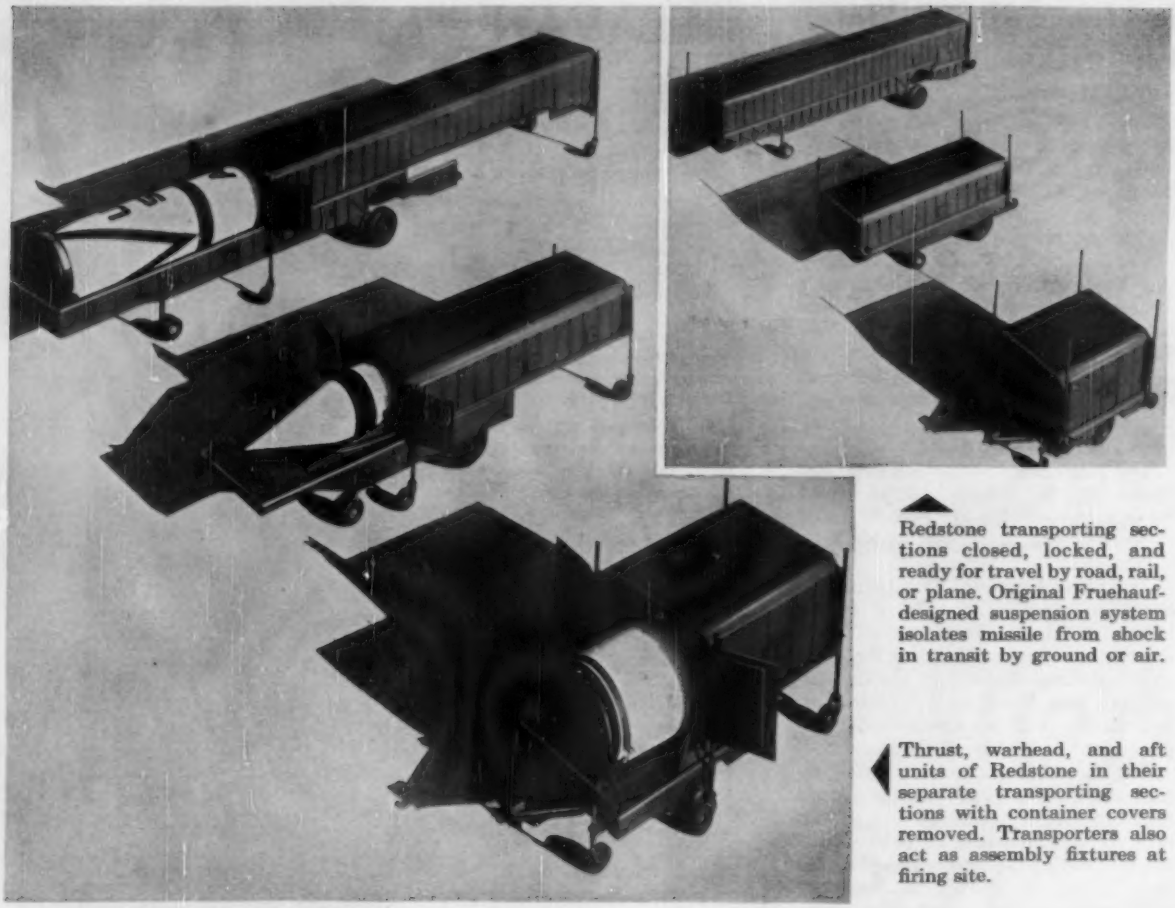
Over-all dimensions of the chamber in which the arc is enclosed are 36-in. high by 18 in. wide. Actual diameter across the arc's three center electrodes is 9-in. Maximum current consumption is 20,000 kw.

The arc will produce temperatures of approximately 26,000F and a steady state heat transfer rate of about 2,000 Btu/sec ft^2. Maximum firing time is approximately 30 sec.

Unlike the new arc, earlier models operated on direct current and were made with only two electrodes, an



PLASMA jet shooting out of General Electric's large air arc will enable researchers to run high temperature experiments on re-entry vehicle models much larger than any that could ever be tested before with plasma jets. Arc is in General Electric's Switchgear Department.



Redstone transporting sections closed, locked, and ready for travel by road, rail, or plane. Original Fruehauf-designed suspension system isolates missile from shock in transit by ground or air.

Thrust, warhead, and aft units of Redstone in their separate transporting sections with container covers removed. Transporters also act as assembly fixtures at firing site.

Redstone Ground Handling Equipment Is Fruehauf-Designed and Fruehauf-Built

Three-Part Redstone Transporter And Container Acts As Assembly Guide At Firing Site

Among the many missiles for which Fruehauf has developed ground handling equipment either as prime or sub-contractor is the Army Redstone.

Typical of the handling problems which Fruehauf engineers are experienced in solving, the Redstone is so designed that it must be transported in three sections, yet requires protection against shock en route via any travel system, and has to be assembled at launching site. The Fruehauf-designed Redstone transporter and container units assist in doing the entire job with maximum rapidity and minimum expense.

Among other important missile projects in which Fruehauf ground handling know-how has made important design or manufacturing contributions are: Nike Ajax and Hercules, Genie, Thor, Regulus I and II, Matador, Bomarc, Atlas, Titan, Corporal, Hawk, Polaris, Sergeant, and Jupiter.

Consult Fruehauf at any time for complete research, design, and manufacturing facilities for *any* ground handling problem concerning missiles, equipment shelters, or weapons systems.

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MISSILE PRODUCTS DIVISION

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anode and a cathode. The plasma was drawn off through the cathode which was hollow. Size of the units was usually designated in terms of the diameter of the anode, with 1¼-in. the largest size heretofore used by General Electric.

The new arc actually has four electrodes: three located in the center of the chamber and a taller graphite sleeve which lines the chamber and is grounded. In operation, steel wool is first placed between the electrodes to provide an easily ionized initial path for the arc; otherwise, the arc will not strike across the electrodes. (Once the arc is struck, the steel wool is quickly consumed). After the steel wool is in place, the chamber is buttoned up, and the air pressure and voltage are raised until the arc strikes.

The arc actually consists of a series of electrical discharges from one electrode to another and intermittently to the sleeve. This theoretically will go on for periods up to 30 sec., but maximum arcing time to date has been 15 sec. Air is introduced tangentially at the bottom of the chamber at a rate of 0.6 lb/sec., swirls up around the arcing electrodes, is changed to a high pressure plasma and is discharged through a nozzle (a hole ranging from ¼ to 1 in. dia.) in the top plate as a high temperature plasma jet. Objects under test are held just outside the orifice.

ARDC Flight Test Center Forms Office for Manned Spacecraft

By Richard Sweeney

Edwards AFB—Looking toward the day when its flight test mission will include manned space vehicles, Air Research and Development Command's Air Force Flight Test Center here has established the office of assistant (to the center commander) for manned spacecraft.

Reporting directly to Center Commander Brig. Gen. Marcus F. Cooper, Lt. Col. Harold G. Russell currently heads the office and is organizing his working groups within the various elements of the center.

First project for the office will be the North American X-15, with the manned spacecraft people representing the Air Force Flight Test Center cognizance in the program.

Presently, the manned spacecraft unit has people within other elements and directorates of the center. At a later date it will combine all people and work within one group.

Two directorates within the center where manned spacecraft figures now are Directorate of Flight Test, and Directorate of Missile Captive Test, formerly the Rocket Engine Test Laboratory and recently renamed to better describe its function.

Manned Spacecraft

In Directorate of Flight Test, manned spacecraft units are set up within several divisions and branches. In addition, within the Directorate's Project Control Office, Richard Harer, former AFFTC test pilot and now a civilian staff member, operates as Manned Spacecraft Project Officer.

In Fighter Operations Branch of Flight Test Operations Division, Capt. Iven Kincheloe is chief of the Manned Spacecraft Section, which also includes Capt. Robert White, and Capt. Robert Rushworth. These three will be USAF pilots participating in the X-15 program.

Flight Test Engineering Division has two branches with manned spacecraft units. Human Factors Branch Chief, Lt. Col. Bert Rowen, is functioning for Manned Spacecraft Human Factors. Col. Rowen currently is USAF's Human Factors Director in the X-15 program, with cognizance over the work done by North American Aviation, National Advisory Committee for Aeronautics and the Navy in this effort, as well as other USAF work applicable to space flight conditions. The work will provide an excellent basis from which logical steps in human factors investigations can be taken.

A Manned Spacecraft Engineering Section has been established within the Flight Research Branch of the Flight Test Engineering Division, with Robert G. Hoey and John L. Wesesky designated for the work.

Booster Responsibility

The Directorate of Missile Captive Test will play a prominent part in manned spacecraft activities later on, when it will handle tests of the rocket boosters which undoubtedly will be used with the spacecraft. Boosters will be chosen elsewhere and will merely be tested for their particular function as part of manned spacecraft work by the Directorate.

Since the manned spacecraft office at AFFTC is concerned mainly with testing of space vehicles, the approach to certain problem areas will differ from that of contractors or weapon systems designers.

One instance is the use of first stage vehicles. Economics would dictate that one-shot waste of expensive boosters would run to exorbitant figures in even a reasonably thorough flight test program, let alone the comprehensive one required by a manned spacecraft weapon system.

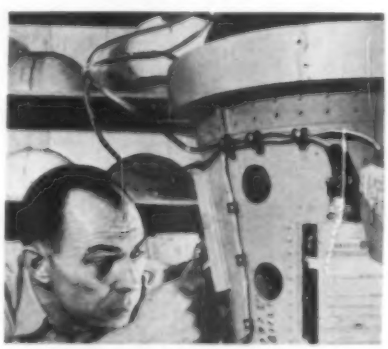
Therefore, one of the aspects which Col. Russell's program is studying is possible developments in airborne and airbreathing vehicles which could be used to get the space vehicle to altitudes and speeds where its own powerplant may take over, or less expensive and lower thrust stages can send the vehicle off into its flight test trajectory. Designs for such systems will be well studied, including such approaches as ramjet carriers, turbojet carriers or any other possibilities.

Role Not Final

The exact role of the manned spacecraft unit has not been made completely final, but a functional outline of its mission touches almost all aspects of space flight.

Instructions indicate the assistant will advise the center commander "on all matters pertaining to manned space flight, represent AFFTC at meetings and conferences concerning manned space flight . . . prepare, coordinate and evaluate plans, work in progress and determine expected results of manned spacecraft programs under way at the center as well as those programs which may conceivably affect the center in the future. . . ."

The manned spacecraft unit's thorough integration into the X-15 program in technical, support, human factors and piloting areas will provide the group with a well-rounded background in manned space flight, on which it can draw for future programs such as Dyna-Soar and those which will follow.



Nose Cone Capsule

Technician works on data recovery capsule carried in Thor intermediate range ballistic missile nose cone. Capsule, designed by General Electric Co., contains instrumentation which backs up telemetry systems which may not be able to transmit through ionized gases surrounding the nose cone during flight. Capsule is designed to be ejected before the nose cone returns to earth.

90% of all U.S. long-range missile test flights are recorded on CEC DataTape

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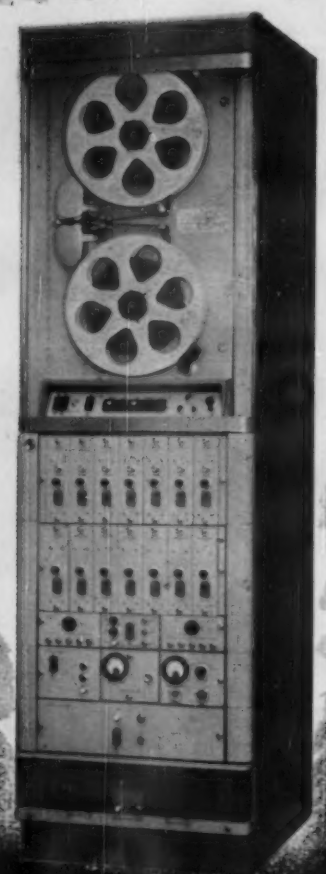

5-752 MAGNETIC TAPE RECORDER/REPRODUCER SYSTEM

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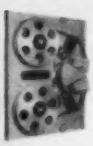
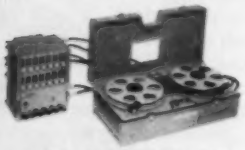
Permits fast, inexpensive conversion of the 5-752 into a continuous loop transport for repetitive playback and data analysis.



DIGITAL MAGNETIC-TAPE RECORDER/ REPRODUCER

5-781 MAGNETIC-TAPE RECORDER/ REPRODUCER (continuous loop)



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ALL-METAL-SURFACE MAGNETIC HEADS
The all-metal-surface of CEC's magnetic heads promotes a self-cleaning action and minimizes head wear. Oxide can't build up on heads to cause drop-outs or loss of high-frequency response.

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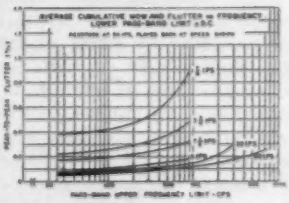
At tape speeds of 1⅞ and 3¾ ips, cumulative flutter in the 5-752 is about 50% less than the flutter found in other tape equipment. Accompanying chart shows flutter recorded at 30 ips and played back at speeds indicated.



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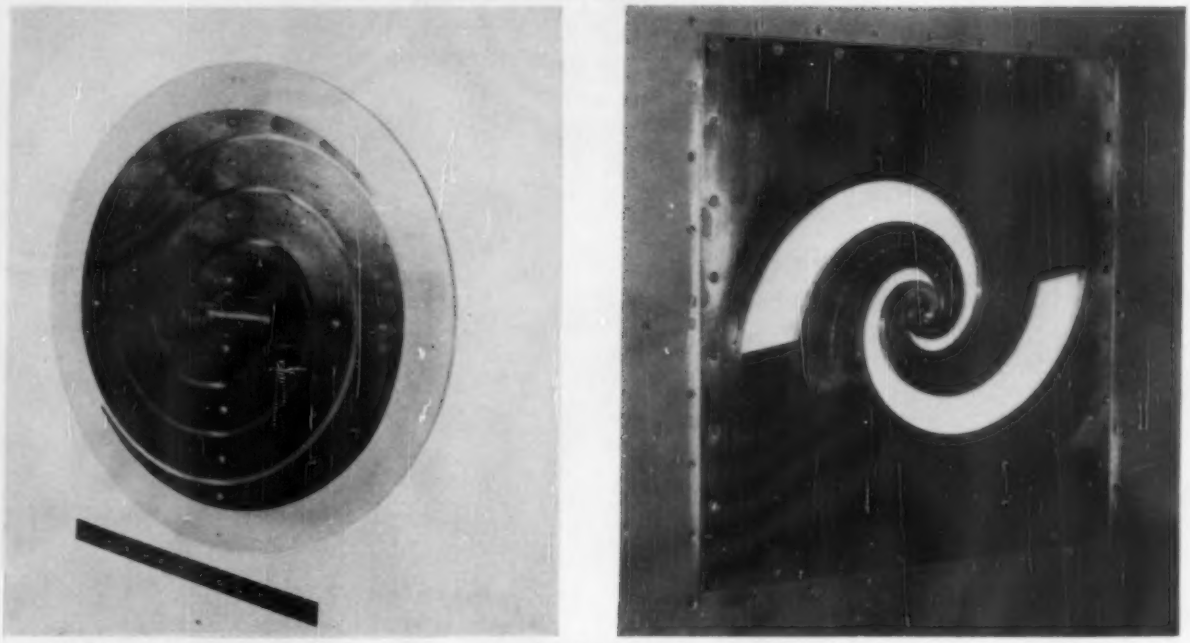

ARCHIMEDES spiral antenna (left), first of several novel broadband antennas for electronic countermeasures use which can operate over bandwidths of 10:1 and higher, was developed by an Air Force engineer. Equiangular spiral antenna (right), which exhibits bandwidths of 20:1 and higher, was developed shortly afterward by University of Illinois scientists under Air Force sponsorship.

Airborne Spiral Antennas Minimize Drag

By Philip J. Klass

Dayton—Discovery of a fundamentally new type of antenna, which can operate efficiently over a wide range of frequencies, is sparking a minor revolution in the design of antennas for electronic countermeasures (ECM) use, particularly for airborne ECM.

New spiral antenna design has spawned a whole family of odd-shaped broadband antennas whose members bear such exotic names as "Archimedes spiral," "Scimitar," and "Valentine." Original spiral antenna design is credited to Edwin M. Turner of Wright Air Development Center's Aerial Reconnaissance Laboratory. Other novel designs have been developed by University of Illinois scientists.

Previously an antenna which could maintain essentially constant impedance and radiation pattern over a frequency range of 1,000 to 2,000 mc. (2:1 bandwidth) was considered good. A bandwidth of 3:1 was considered exceptional.

Today, spiral antennas can be produced whose impedance and radiation pattern remains essentially constant over a 10:1 to 20:1 bandwidth. Figures of 30:1 or even higher may be possible with some compromise in performance.

Spiral antennas in some configurations can be designed to operate at frequencies as low as 30 mc., or as high as 30,000 mc., and this upper limit may eventually reach 120,000 mc., according to Turner. Most of the spiral antenna configurations can be fabricated using etched-circuit techniques, hence are relatively inexpensive to produce. Most of the configurations are suitable for flush mounting, the others are generally low-drag.

Bomber Requirements

Addition of electronic countermeasures equipment to bombers has resulted in phenomenal growth in the number of antennas they must carry. Modern high-speed bomber may require more than 100 antennas of conventional design, to enable it to cope with enemy electromagnetic radiation in any portion of the spectrum. These must be flush-mounted to reduce drag and so located as to give desired radiation pattern, yet not cause mutual interference with other antennas.

Broadband capabilities of new spiral antennas enable one such device to replace five or more conventional ECM antennas formerly required. New design also makes it possible to produce flush-type antennas capable of operating at frequencies below 200 mc., previously difficult or impossible.

First of the new spiral antennas was conceived and constructed by Turner in 1953. His antenna, for which a patent application has been filed, took the form of an Archimedes spiral in which both the arms and space between are of constant width. Device was remarkably broadband compared with then-existing antennas, exhibiting a bandwidth of 8:1. Turner subsequently received an Air Force incentive award for his work.

The commendation calls it a "major advance in the antenna art."

Some 12 years earlier, Sergei A. Schelkunoff, Bell Telephone Laboratories mathematician, had enunciated the principle that an antenna of sufficient length, whose shape was defined entirely in terms of angles, should exhibit impedance and radiation patterns which were independent of frequency.

At the University of Illinois' antenna laboratory, this principle had been under study and investigation by Prof. V. H. Rumsey, laboratory director. Turner's Archimedes spiral antenna spurred Rumsey to apply Schelkunoff's principle to spiral-shaped antennas and to propose another basic type, called "equiangular spiral."

Development carried on in 1954 by the University's John D. Dyson, under Air Force sponsorship, resulted in an antenna which exhibits greater efficiency

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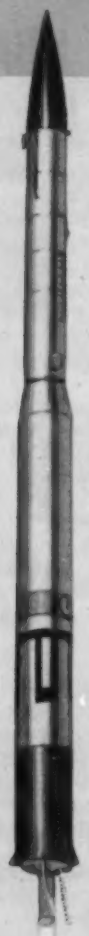

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Current Rating 10 amps ind. at 28 VDC
10 amps 115 VAC
Tested to MIL Spec. MIL-E-5272A and vibration to 50 G's
10 to 2000 cps.

Weight 7 ounces
Cubic Volume 6 cubic inches
Stability —65° to 325° F tolerance of plus or minus 5%

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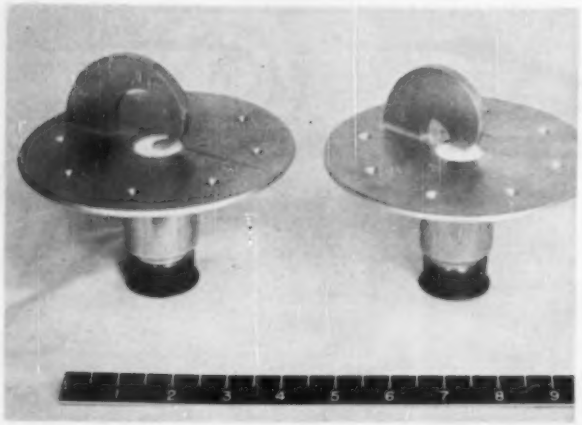
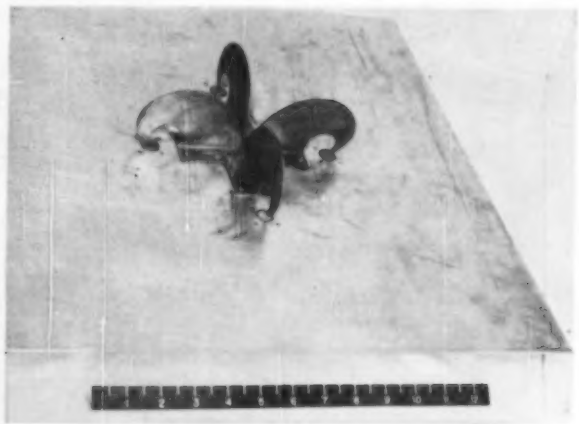




SCIMITAR antenna, adapted from equiangular spiral, provides different characteristics, bandwidths of 10:1. Units can be designed to operate from 30 mc. to 30,000 mc. High-power S-band units are shown at left. Scimitar cluster (right) gives different pattern.

and bandwidth than the original Archimedes spiral.

In 1955, University of Illinois' Prof. R. H. Du Hamel proposed another basic type of wideband antenna which combines the angle concept with periodic structures. The resulting "logarithmically periodic antenna," as it is called, exhibits electrical characteristics which repeat periodically as the frequency is varied, with only minor changes over each period. University's D. E. Isbell carried out development which confirmed Du Hamel's theory.

In 1956, WADC engineers applied the equiangular spiral principle developed by University of Illinois and came up with the "scimitar" antenna, named for its shape. This antenna exhibits sufficiently different characteristics to almost qualify it as another basic type.

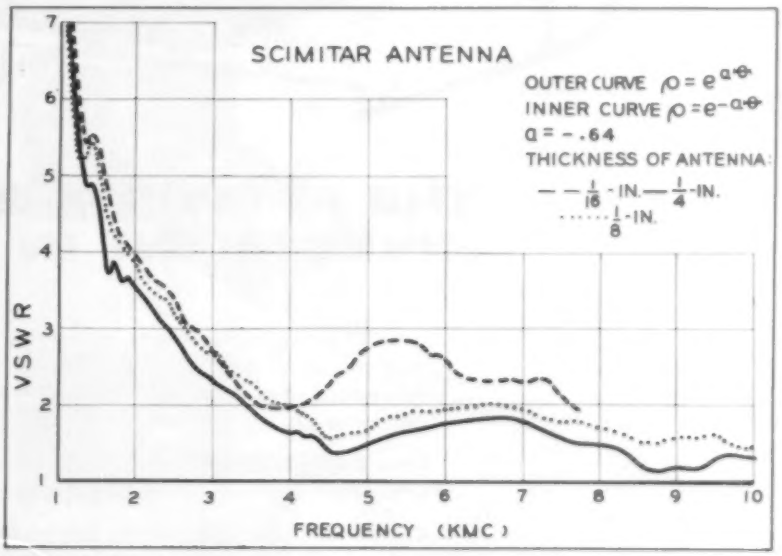
Each of these four antenna types has certain advantages, some disadvantages depending upon the application. All are in use today.

• **Archimedes spiral** produces bi-directional, circularly polarized radiation and exhibits bandwidths of about 10:1. It can be fabricated in smaller sizes than the equiangular spiral and periodic slot, permitting operation at higher frequencies. This type is well suited to flush mounting.

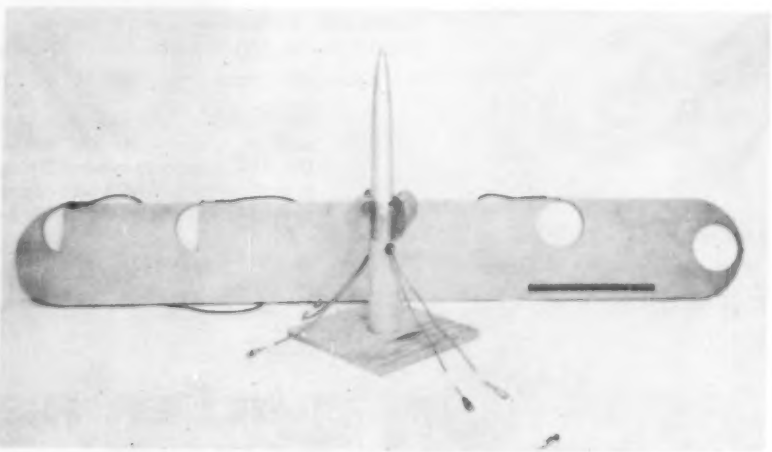
• **Equiangular spiral** also produces bi-directional, circularly polarized radiation. However, it is more efficient than the Archimedes spiral, exhibits bandwidths of 20:1 and higher. Unit is suitable for flush mounting.

• **Scimitar** has very high efficiency, power handling capability, exhibits bandwidths of better than 10:1. By using clusters of several Scimitar antennas, variety of radiation polarizations and patterns can be obtained. Scimitar antenna can be flush-mounted in a cavity or mounted externally since it adds very little drag.

• **Logarithmically periodic** produces linearly polarized radiation, has demon-



PERFORMANCE characteristic of the early scimitar antenna shows Visual Standing Wave Ratio vs. frequency.



EXPONENTIAL loop antennas can consist merely of suitably shaped hole fabricated in tip of wing or tail surface. Scimitar antennas can be shaped to perform avionic function as well as serving as stabilizing surfaces on a guided missile, as model shows.

Official U.S. Navy photograph

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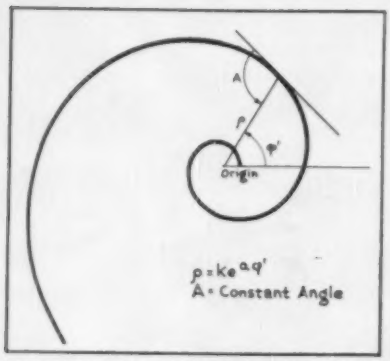


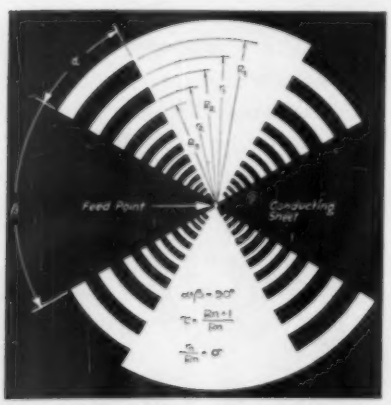
EQUIANGULAR spiral antenna shape is defined by angles and constants.

strated bandwidths above 20:1, but may be more difficult to manufacture to required precision at very high microwave frequencies.

Several novel antennas have come out of extensions of the Scimitar design by placing two such antennas in a back-to-back configuration. One, because of its shape, is called a "valentine antenna." Another, with different design constants, is called the "exponential loop." Both are characterized by broad bandwidths, high efficiency, wide beams, and can be fed in either balanced or unbalanced fashion.

Because this type antenna does not require electrical isolation from the airplane structure, equivalent radiators can be made by fabricating suitably shaped holes in the tips of aircraft/missile wings or stabilizers.

Holes would be covered by dielectric shields to prevent windstream disturbance. Small holes can provide efficient antennas with patterns essentially free of lobes, Turner says. For example, for operation at 1,000 mc., a four-inch diameter hole provides a 10:1 bandwidth with a VSWR (Voltage Standing Wave Ratio) of less than 2:1, accord-



LOGARITHMICALLY periodic antenna is pseudo broadband device whose characteristics repeat at periodic intervals as operating frequency is varied.

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451218 "CUBIC INCH"

SIZE: One inch cube
WEIGHT: 2 ounces
RESOLUTION: to 300 wires (0.33%)
RANGE: 0-15 to 0-50 psi (a, d or g)

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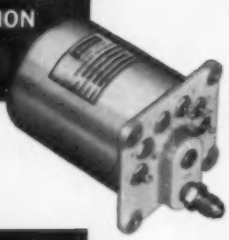


451212 HIGH LEVEL OUTPUT

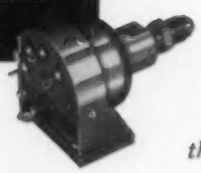
ACCURACY: 1% of reading for most applications (considering linearity, hysteresis and repeatability)
RESOLUTION: 2000 wires (0.05%)
RANGE: 0-10 to 0-50 psi (a, d or g)

LOW PRESSURE

45154 HIGH VIBRATION

VIBRATION: 25g to 2000 cps
REPEATABILITY: 0.8%
RESOLUTION: to 250 wires (0.4%)
RANGE: 0-10, 0-15, 0-20 psi (a, d or g)

HIGH PRESSURE



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RESOLUTION: to 400 wires (0.25%)
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Component Life: The H-23D's 250 horsepower is available full-time, without restrictions warning of jeopardized service life. In fact, all existing components are ***designed*** to accept considerably greater horsepower and to attain an overhaul period beginning at 1000 hours.

Functional Versatility: More power... more cabin space... further qualify the H-23D as a multi-mission helicopter, backing up a basic Army concept: more utility from fewer units.

The H-23D is now prepared to receive a new 305 horsepower engine, without further major modification. The resulting UH-12E (prototype now flying) has already demonstrated a performance which will capture new missions beyond those previously conceived for this helicopter class.

HILLER HELICOPTERS

PALO ALTO, CALIFORNIA

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ELECTRONICS

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Temco's capabilities in electronic research and development . . in systems management . . are making Temco a leader in the electronics field. Take Temco's work in autopilot development, for example. While converting several Army Signal Corps L-17s to radio-controlled reconnaissance drones, Temco found no suitable "commercial" autopilot. So Temco engineers developed their own . . an inexpensive, simplified unit that met all special requirements . . provided wide-range reliability and control.

Then Temco engineering came up with a low-drift d-c servo-system and a low-power d-c "pecking" amplifier . . took the basic autopilot they had developed . . miniaturized and repackaged it for use in Temco's rocket-powered transonic Teal target drone. The result: "Teal" became the first "missile" of its type to be successfully launched from a swept-wing aircraft and to operate effectively at altitudes up to 50,000 feet.

Today this know-how is directing development of "Corvus" . . the Navy's highly classified "stand-off" air-to-ground missile . . with Temco as weapon system manager. It is being used in the development and production of special flush-mounted antenna systems . . microwave devices . . advanced guidance systems . . airborne TV systems and many classified projects.

Temco's complete systems management capabilities are ready to meet your challenge.

VALENTINE antenna (top) and exponential loop (below) are two additional broadband antennas to be derived from the equiangular and scimitar design concepts.

ing to Turner. If a VSWR of 10:1 is tolerable over the 10:1 bandwidth, diameter of hole can be reduced to only one inch.

Air Force is not releasing performance details on the current state of spiral antenna art. However, an early WADC report that was recently declassified reveals the following characteristics of Archimedes spiral antennas tested in 1954:

• **Shapes:** Variety of configurations were investigated, including flat circular, elliptical, rectangular and circular-bent over a curved surface, corresponding to antenna for mounting on leading edge of a wing. WADC reports that a curved configuration tends to reduce antenna bandwidth somewhat.

• **Frequency range:** Tests indicate that antennas radiate efficiently between 100 and 10,000 mc. Physical size considerations suggest useful limit will be about 50 to 15,000 mc., report says.

• **Radiation pattern:** When antenna aperture diameter exceeds ½ the operating wavelength, a 70 to 110 deg. solid cone pattern results. A cavity backing is essential because of spiral antenna's natural bi-directional radiation characteristics. Cavity depth is not critical, report indicates.

• **Impedance:** Antenna input impedance can be stabilized between 40 and 70 ohms over frequency range of 10:1 or more.

• **Feedpoints:** Two methods of feeding Archimedes spiral were investigated. One connects spiral conductors at center to an unbalanced coaxial line. Other arrangement connects center conductor of coaxial cable to outside end of one of the spiral arms, connects coaxial shield end of other spiral arm and to grounded cavity. First type feed produces horn-type radiation pattern, while second gives stub-type antenna performance, report says.

The equiangular spiral name comes from the fact that a radius vector drawn from the origin to any point on the curved surface makes the same angle with a tangent to the curve at the point of radius vector intersection.

Shape of the antenna is defined by the following equation:

$\rho = ke^{a\phi}$

Where: ρ Radius vector from origin to point on curve.
ϕ Angle of rotation of radius vector.
k, a Constants.

Variety of balanced equiangular spiral antennas, consisting of two spiral arms, or slots, have been investigated by University of Illinois antenna laboratory.

Two spiral arms are identical, concentric, but displaced 180 deg. starting at the center of the antenna. Curvature of the outer edge of a spiral arm, is defined by equation: $\rho_1 = ke^{a\phi}$. Curvature of inner edge of spiral arm is defined by equation $\rho_2 = k\rho_1$. Antenna operation will be essentially independent of frequency so long as length of the spiral arm is equivalent to one wave-length at the lowest operating frequency used.

Tests indicate that consistently good patterns can be obtained with spirals of only 1¼ turns, and one unit with only ¾ of a turn exhibited acceptable patterns, according to a report by John Dyson of University's antenna laboratory.

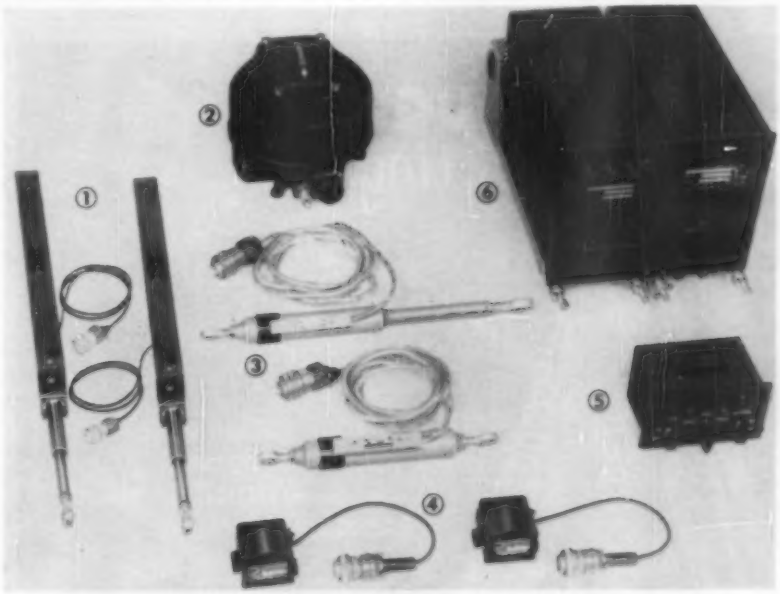
Antenna radiates a broad lobe perpendicular to the plane of the antenna from both front and back of structure. Bandwidths in excess of 20:1 have been obtained and there "is no indication that this could not be extended indefinitely," Dyson's report says.

Voltage Standing Wave Ratio of typical balanced equiangulat spiral slot varies between about 1.2 and 1.75 over frequency range of 1,000 to 10,000 mc. When same antenna was operated down to 400 mc., maximum VSWR was about 2.9.

The WADC-developed Scimitar is a simplified type of single-arm equiangular spiral antenna. It bears some resemblance to a thin stub antenna which has been folded over.

Scimitar shape is obtained by using one value for constant "a" in establishing outer curve, another value for inner curve.

For one set of Scimitar antennas constructed by WADC, value of 0.35 was used for outer curve, values ranging between 0.05 and 0.25 were used for inside curve. Lower values



Automatic Helicopter Flight Controls

Helicopter automatic flight control system developed by Sperry Gyroscope Co. provides same control capability as systems for fixed wing aircraft. First operational systems are being installed in Vertol 44 helicopters for the Royal Swedish Navy. System, which weighs just under 40 lb., could be used for remote control of helicopter drones. Components are: (1) Bungee pick-offs for centering control stick and converting pilot's stick movements into electrical signals, (2) vertical gyro for providing pitch-roll reference, (3) force links to convert collective stick and rudder forces to electrical outputs, (4) linear accelerometers to sense lateral and longitudinal accelerations, (5) pilot consol, (6) amplifier assemblies, including altitude sensor which can be used individually.

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Aeronutronic Systems, Inc., a subsidiary of Ford Motor Company, is expanding military and commercial programs in Glendale and at modern, new facilities overlooking the Pacific Ocean at Newport Beach, California. Outstanding career opportunities for qualified scientists and engineers who are U.S. citizens, and have B.S., M.S. or PhD degrees, are available in the following fields:

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Qualified applicants are invited to send resumes and inquiries to Mr. K. A. Dunn.

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appear to give better results, according to a recent WADC report.

Roughly speaking, scimitar acts like a stub antenna in the horizontal plane (θ = 90 deg.), and like a dipole in the vertical plane (ϕ = 90 deg.), according to Turner. Formal theory has not yet been developed which fully explains Scimitar operation. Despite this, there is sufficient empirical knowledge to permit design of Scimitars for most applications, Turner says.

Logarithmically periodic antenna, developed by University of Illinois, can take the form of two metal triangles, joined at their apexes, with rectangular "teeth" located on two sides of the triangle. Shape of this antenna is defined in terms of the radius from antenna center to each of the teeth and in terms of the angles swept by the teeth and the void between the teeth on the two triangles.

Radii of the teeth are selected so that the ratio of the radius from one tooth to the corresponding point on the adjacent tooth is a constant. This constant determines the period at which the antenna characteristics repeat.

A flat (planar) periodic antenna of this type will exhibit half-power beamwidths of 40 to 80 deg., for radii ratios of 0.25 to 0.81, Illinois investigators found.

General pattern shape is bi-directional, having approximately equal principal plane beam-widths. Antenna is fed from its center.

If the two serrated triangles are folded over so that the angle between them is less than 180 deg., the antenna will radiate a unidirectional pattern as the included angle reaches about 40-50 deg. Using a periodic antenna with a diameter less than a half wavelength, folded to give included angle of 40 deg., University of Illinois' Isbell obtained essentially unidirectional radiation over a 20:1 bandwidth—300 to 6,000 mc. It is expected that the upper limit can be extended beyond this figure, limited only by the precision with which tiny teeth can be cut near center of the device.

Sizable number of companies have, or are currently investigating new spiral antennas and their broadband derivatives. List is known to include: Airborne Instruments Laboratory, Dalmo Victor, Farnsworth Electronics, General Electric, Gibbs Manufacturing, Hallicrafters, Martin, Melpar and Temco Aircraft Co. List of universities and research groups includes: Johns Hopkins, Massachusetts Institute of Technology, Ohio State and Stanford Research Institute.

Variety of novel-shaped spiral antennas can be expected to show up soon on new aircraft and missiles to play an important role in extending electronic countermeasures capability.

CAA Radar Delivery Set for June, 1960

Dallas—Delivery of first ASR-5 surveillance radar system by Texas Instruments, Inc., is scheduled for June, 1960, with production rate of two units a month following initial delivery.

Company has $5,928,000 contract from Civil Aeronautics Administration, which is expanding its surveillance radar network to 19 new cities (AW June 30, p. 33). ASR-5 is similar to ASR-4 system previously ordered from the Dallas electronic firm.

The radars will cover altitudes up to 27,000 ft. in providing approach and departure control in airport areas. ASR-5 will have circular polarization and moving target indicator, and it will be able to handle a 30 ft. radar beacon antenna when such equipment is available.

The new radars will be installed at airports in Tulsa, Okla.; Richmond, Va.; Greenville, S. C.; Roanoke, Va.; Harrisburg, Pa.; Greensboro, N. C.; Toledo, Ohio; Washington, D. C.; Chattanooga, Tenn.; Bristol, Tenn.; Corpus Christi, Tex.; Wilkes-Barre, Pa.; Wilmington, Del.; Binghamton, N. Y.; Columbia, S. C.; Phoenix, Ariz.; Des Moines, Iowa; San Diego, Calif.; and Amarillo, Tex.

Digital Computer Used in Relay Design

Complex design problems relating to new relays for missiles and aircraft are being solved with a digital computer at Leach Corp.'s Relay Division, Los Angeles. Computer is being applied to design of relay prototypes to achieve reduction in size and weight and refinements to boost reliability.

Use of the computer makes possible fast determination of 14 basic variables in relay design, including coil ampere turns; radius, length and separation of cores; armature and yoke length, width and thickness; working air gap length and area; distance of core to pivot point; and magnetic material selection.

Leach's continuing reliability program has led to these refinements in relay design:

- **Elimination of silicone rubber** sleeving, glass yarn and silicone varnished wire because of gassing characteristics.
- **Modification of contact form** and inclusion of bifurcation to give increased reliability.
- **Backfilling with special** high purity grade of nitrogen.
- **Extensive use of Teflon** insulation.
- **Elimination of rosin flux,** certain soldering operations, and cadmium plating.
- **Complete measurement** of contact drop.

New Air Collision Study

"Fundamentals of Collision Avoidance," a 200-page detailed analysis of the problem based on more than two years of company-financed study has been published by Collins Radio Co. The report analyzes many subtle complexities of the air collision avoidance problem that are often overlooked by newcomers in the field. It includes an analysis of the basic air collision problem, dynamics of collision hazards in turbulent air, aircraft response in turbulent air and the nature of collision encounters in both random and directed traffic. The report does not recommend any solutions or discuss different possible anti-collision systems.

Copies of the report are available to help industry solve the difficult collision avoidance problem. Write: Dr. David McCoy, Collins Radio Co., Cedar Rapids, Iowa.

FILTER CENTER

▶ **New Microwave Amplifier Advance**—Novel low-noise solid-state amplifier technique, which enables germanium diode to amplify at 6,000 mc. without cooling to near-absolute zero temperature or magnetic field required by Masers, has been developed by Radio Corporation of America's research laboratories. New parametric microwave amplifier also has advantage of being able to operate with a local oscillator ("pumping") frequency which is lower than incoming signal frequency. Device, expected to operate in the 1,000 to 10,000 mc. band, can be packed in space of only four cubic inches, requires power supply of only fraction of a watt, according to RCA.

▶ **Admiral Wins Navy SSB Award**—Admiral Corp. has won competition to produce Navy Bureau of Aeronautics' new airborne single sideband set, AN/ARC-37, originally developed by Stanford Research Institute. Unusual twist: Admiral, major source for Air Force airborne HF communications in the past gets Navy SSB contract, while Collins Radio, principle supplier of BuAer airborne communications in the past is now building AN/ARC-58 single sideband sets for Air Force.

▶ **Heading Errors Loom Large**—Largest single source of inaccuracy in Doppler auto-navigators comes from errors in gyro heading reference and situation shows no immediate signs of change, according to Lt. Col. D. J. Freund, deputy chief of Navaids Branch, USAF Headquarters. Present progress in Doppler system design suggests that present weights will be cut roughly in half by 1965, with fully automatic auto-navigators weighing 100-150 lb., including computer and heading reference. Modest improvement in accuracy is also expected by 1965.

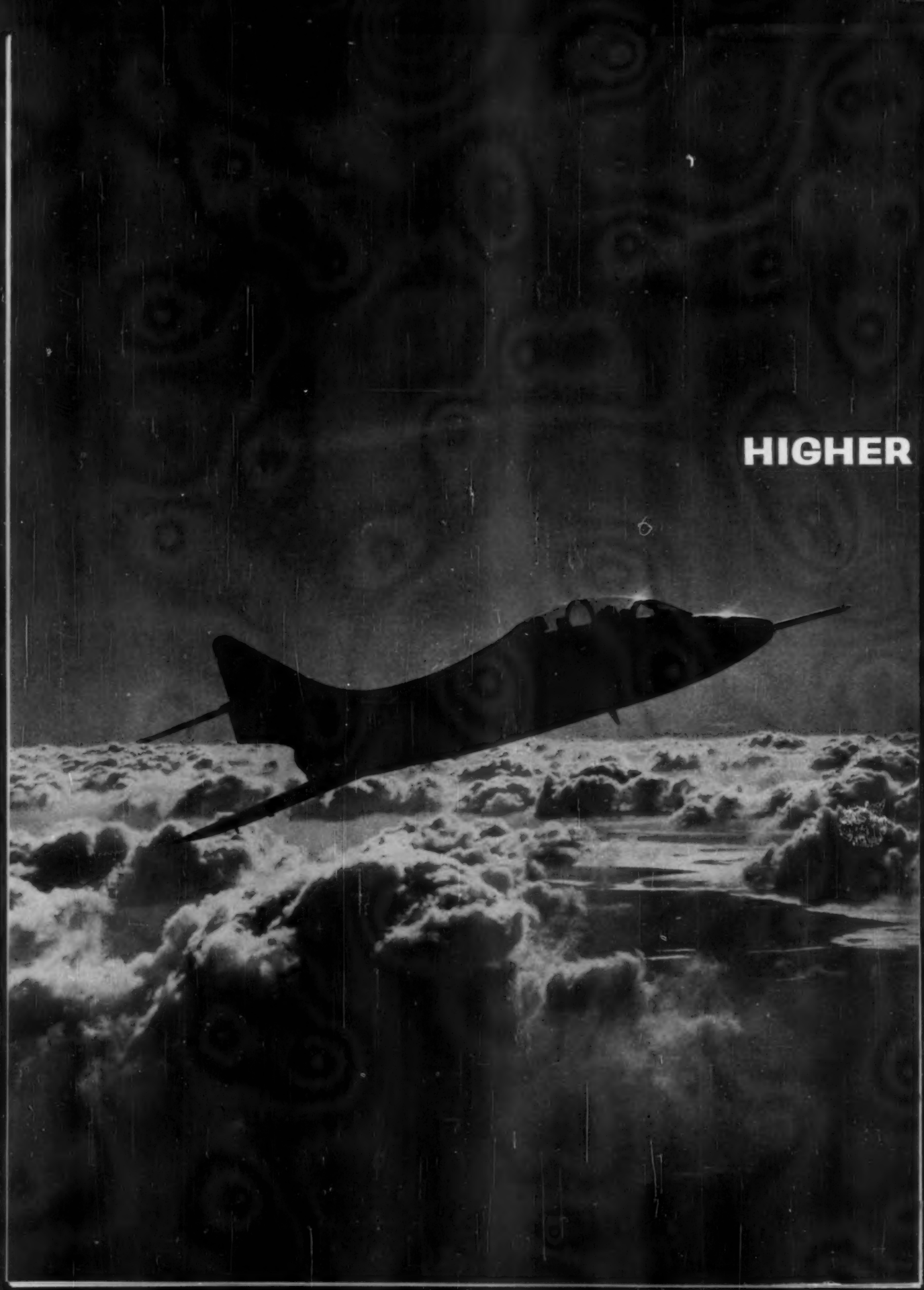
▶ **PAA Confirms Dectra Claims**—Pan American Airways tests of Dectra long-range navigation system in North Atlantic have confirmed accuracy claims of British Decca, its developer, according to PAA's Ben McLeod. Using celestial, visual sightings and Loran, PAA finds Dectra is accurate to within 5 mi. near base line, within 10 mi. off base line. PAA also is evaluating several Doppler systems and new Edo Loran which it will install on new jetliners.

▶ **Lear Autopilots for F-27**—Lear L-5 or L-102 autopilots and Lear Integrated Flight Equipment (LIFE) are now offered as optional equipment on Fairchild's F-27 (Friendship) turboprop transport.

▶ **Severe Changes in Avionics?**—Avionics and military electronics field is undergoing "severe changes," according to Dr. W. R. G. Baker, retiring president of Electronic Industries Assn. "Increasingly complex manufacturing requirements and military dependence on constant research and development have narrowed the field of qualified bidders," Baker says. "The day when an electronic manufacturer could turn out standard components or equipment in large volume for the military seems to have ended—at least for the present. Outside of the research laboratories, it is doubtful that the dawning space age will help the profit or production rates of the electronics industry during the next few years," Baker believes.

▶ **Sign on Dotted Line**—Major contract awards recently announced by avionic manufacturers include:

- **Hallamore Electronics** division of The Siegler Corp., Anaheim, Calif., has received $600,000 contract from Northrop's Radioplane Division for television equipment to be used in battlefield surveillance drones.
- **Tele-Dynamics Inc.,** Philadelphia, reports contract for more than $1 million from Reaction Motors for data acquisition and reduction equipment to be installed at Naval Air Test Facility, Lakehurst, N. J.
- **Ampex Corp.,** Redwood City, Calif., will supply airborne tape recorders to Navy's Bureau of Aeronautics under new $1.2 million contract.
- **Sperry Gyroscope Co.** reports $3 million contract from Chance Vought to develop and produce all-attitude flight control systems for Navy's F8U-3.


HIGHER

EDUCATION

The education of a Navy pilot is high at the start. He has a minimum of two years of college before he joins NAVCAD. By the time he wears wings of gold, his education has gone up by $110,000 worth of training. Flying in a Grumman F9F-8T Cougar fighter-trainer, his education is literally high.

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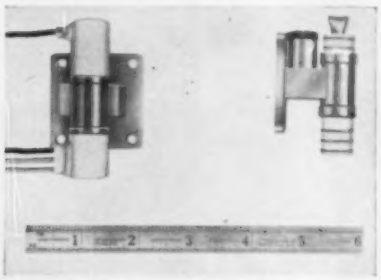
NEW AVIONIC PRODUCTS

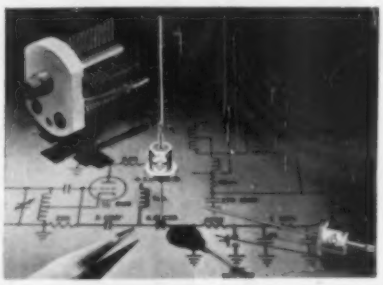
Components and Devices

• **Ceramic-metal reflex klystrons,** Series 1K20, cover the range of 8,500 to 11,700 mc. at output power levels to 50 mw. Designed for airborne and missile use, tubes feature integral ex-



ternal tuning cavities, will withstand vibration levels of 15Gs in any reference plane with less than 100 kc. frequency deviation. Klystrone series is rated at plus 250C seal temperature. Eitel-McCullough, Inc., San Bruno, Calif.

• **High Q silicon variable capacitor,** called Semicap, is designed to replace mechanical capacitors and other variable reactance elements. Semicap has a Q of 1,000 plus at 1 mc. with a 10 to one capacity ratio within its peak



inverse voltage rating of −200 vdc. Unit has linear voltage versus frequency calibration and is virtually insensitive to variations in temperature, according to the manufacturer. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

• **Four terminal ferrite circulator,** Model X442A, operates over the frequency range from 8.5 to 9.6 kmc., can be used to replace a conventional radar duplexer. Unit isolated transmitter from receiver t-r tube by at least 20 db., with antenna reflections only directed to the t-r tube. In such applications, no at-r tube is required. Forward insertion loss is 0.5 db., with a vswr of 1.20 with all arms terminated. Power transmission capability is 250 kw. peak, 250 watts average. Op-

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Today Ontario International Airport provides rapid, efficient fueling service for commercial, military, business and private aircraft . . . in fact just about anything that flies. Growth has been rapid . . . gallonage has increased *twenty* times in the five years Les has been with Shell.

How does he do it? Les picks up valuable merchandising tips from the Shell dealer magazine. And through the Shell Aviation Specialist, Les keeps posted on new ways to build the kind of service fliers want.

A key part of his service program is the Shell Credit Card System . . . a time-saver designed to help fliers meet exacting schedules.

Business is good at Ontario. In fact it is so good that Les is looking forward to expanding his facilities. Plans include a new 2,000-foot runway extension to accommodate the ever-increasing traffic.

The fine reputation of the Les Farrar Aviation Service is widespread and still growing. As for the future? Les himself will tell you that with Shell helping him in every venture—the sky's the limit!

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Studying airport expansion plans (left to right) are Art Clark, vice-president of Les Farrar Aviation Services; Thomas E. Flaherty, Airport Manager; Fred Stewart, Shell Aviation Representative; and Les Farrar.

Giant military transports come to Ontario for modification by Southern California Aircraft Corporation and Lockheed Aircraft Service Corporation. They rely on Les Farrar for fine service and Shell for high-quality fuels and lubricants.

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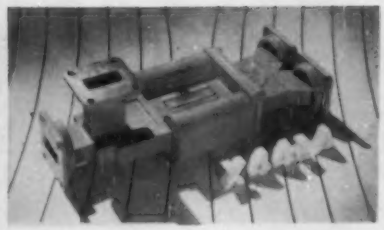
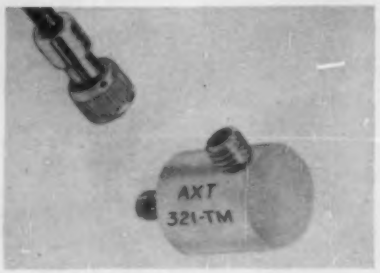


erating temperatures are from −55C to 125C. Over-all length is 8.4 in. Cascade Research Division, Monogram Precision Industries, Inc., 63 Victory Lane, Los Gatos, Calif.



• **High temperature,** self generating accelerometers, called the Glennite AXT-Series, capable of continuous operation at temperatures from −100F to 500F with an accuracy of ±5% of actual reading. Unit exhibits less than ±5% change in sensitivity over total temperature range, are available with resonant frequencies to 30 kc. and sensitivities to 10 mv./G. Series is designed for measurement of shock and vibration in aircraft and missiles over a range of 1/100 to 1,000 G over frequencies of 3 to 10,000 cps. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

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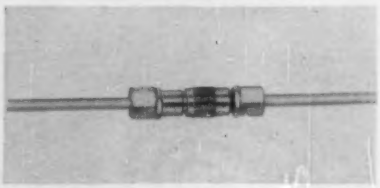

• **Subminiature r.f. coaxial** cable connectors, called "Cub" Series, are less than one-half the size of standard BNC connectors. Designed for microwave use, connectors will handle freqencies to 10,000 mc. wtih low VSWR, are impedance matched for use with RG-188/U, RG-196/U, RG-187/U, and RG-195/U coaxial cable. Design prevents change in contact position through the temperature range from −65-300F. Dielectric strength is 2,000 vdc. at sea level. Cub series requires no special tools for assembly, will withstand pull of 40 lb., and meet MIL-C-8384 water immersion specifications. Dage Electric Co., Inc., 67 North Second St., Beech Grove, Ind.

• **Subminiature servo control clutch,** Model FCX-59, is said by the manufacturer to have the fastest response time of any known type of mechanical, hydraulic or magnetic actuator. Fitting a standard ½ in. dia. servo mount, unit has a response time of approximately 0.9 milliseconds to the first

time constant of maximum torque. Torque is 8 oz. in. minimum guaranteed. Control wattage is 1.1 watt maximum. Average temperature is sufficiently low for continuous operation without overheating or performance shift. Magtrol, Inc., 240 Seneca St., Buffalo 4, N. Y.

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

The Goodyear Tire and Rubber Co., Akron, Ohio, nose wheel assembly, spares for T-29 aircraft, (PR CO-8-038-1105), $31,790.

Jack & Heintz, Inc., Cleveland, Ohio, generator, 30 d.c., aircraft, 400 amp., 3000/8000 rpm., AF type Q-8, reverse rotation axial inlet for F-89D aircraft. (PR SA-8-03C1-4688), $66,675.

Luria Engineering Co. Division, Luria Steel & trading Co., N. Y., N. Y., allied construction and support of MB-3A docks at Walter AFB, N. M., for B-52 bomber program, (PR PM-8-8X-5242), $125,060.

Firestone Tire and Rubber Co., Los Angeles, cell assembly for the aft auxiliary bomb-bay fuel tank on WB-50 aircraft and foreward bomb-bay fuel tank on B-47 aircraft, (PR SM-8-03L-5010 and amendments 1 and 2), $59,445.

Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J., R3350-32W aircraft engines and data for P2V aircraft, MIPR R58-706-85-NOas), $2,046,-000.

Cedar Engineering Division, control Data Corp., Minneapolis, Minn., transmitter accelerometer, type TRU-3/A for use in F-105 and F-106 aircraft, (PR PE-8-05C-3259, -1 and PE-8-05C-3349), $71,156.

Goldberg Bros., Denver Colo., reel, PH-311, 16mm, 800 ft. capacity; reel, PH-382, 16mm, 1,200 ft., capacity and ground support equipment, (MIPR R58-12216-SC-24 and amendment #1 and MIPR R58-12239-SC-24 and amendments 1 and 2) $28,992.

Waste King Corp., Los Angeles, Calif., product improvement of type MA-1 pitot tube, (PR PE-8-05C-3200), $29,675.

The General Tire and Rubber Co., Akron, Ohio, nose wheel assembly for T-33A aircraft, (PR PE8-03B-3471 and 00-8-03B-1119), $138,348.

B. F. Goodrich Aircraft Products Division, B. F. Goodrich Co., Dayton, Ohio, wheel and brake assemblies for H-37 aircraft, (PR PE-8-03B-3581), $25,455.

Schulz Tool and Manufacturing Co., San Gabriel, Calif., flight pressure refueling nozzle, type MA-2 for F-100, F-101, F-105 and F-84F aircraft, (PR OC-8-03F-0629 and PE-8-03F-3562), $44,180.

The General Tire and Rubber Co., Akron, Ohio, wheel assembly, tip protection, 32 x 8.8 for B-52G aircraft, (PR PE-8-03B-3452), $27,020.

The Lewis Engineering Co., Naugatuck, Conn., temperature indicator, type MJ-1 for use on B-52G, B-58A and KC-135A aircraft, (PR PE-8-05D-3503), $38,499.

North American Aviation, Inc., Los Angeles, incorporation of ECP 239 and the adding of additional trainers for F-100D mobile training detachments, (PR PH-7-28-7539), $17,239.

North American Aviation, Inc., Los Angeles, Calif., related equipment and data for F-100D/F MTUs, (PR PH-8-28-7069), $1,148,368.

Aero Design and Engineering Co., Bethany, Okla., RL-26D Army liaison airplane, (MIPR R58-809-TC and amendment 1 and 2), $316,000.

Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J., product improvement engineering services for the J65 engine products during FY-58, (MIPR R57-1078-56-Aer and amendment #2), $3,-950,000.

Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J., R1820-82A engines for S2F-3 aircraft, (MIPR R58-653-2 NOas), $1,033,816.

AiResearch Manufacturing Co. of Arizona Division, the Garrett Corp., Phoenix, Ariz., starters, pneumatic, aircraft engine, type MB-3 for F-100 and KC-135 aircraft, (PR PE-7-03J-4907), $1,130,162.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., indicator, indicated airspeed-Mach number, type AVU-1/A for use on F-105 and F-106 aircraft, (PR PE-8-05C-3539), $2,244,056.

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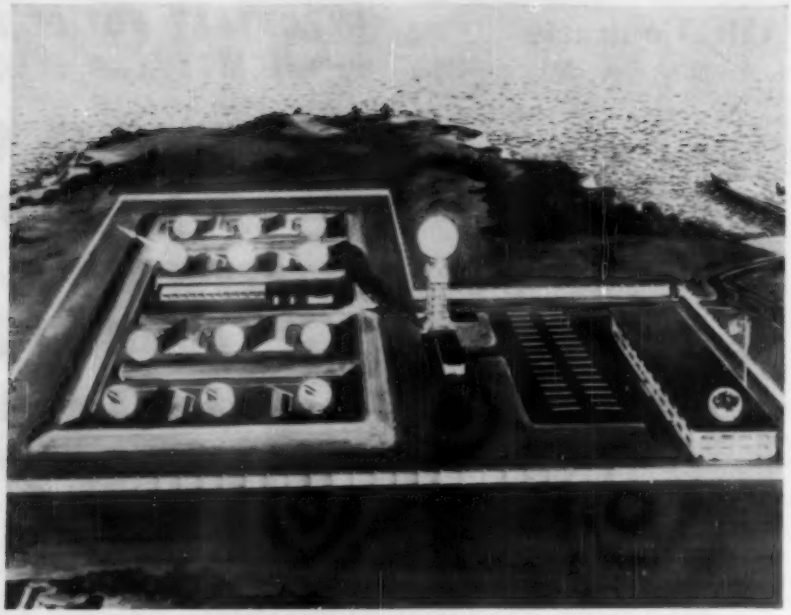
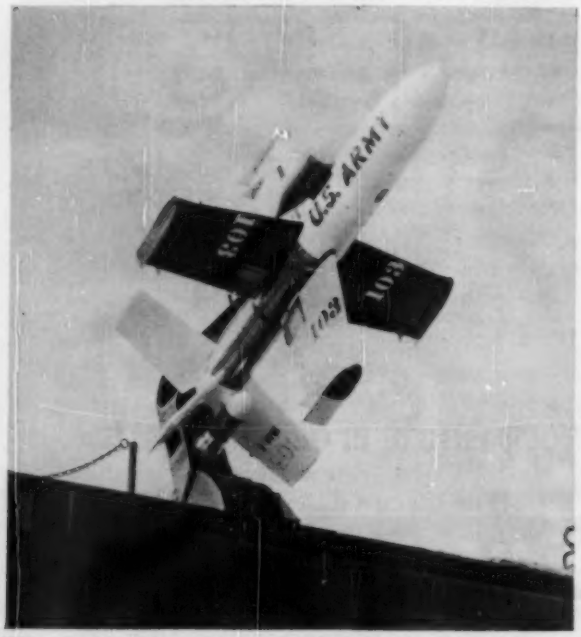


Army Hawk is launched (left). Drawing at right shows plan for firing Hawk through domes which protect launchers from weather.

Army Develops Missiles for Use In Field

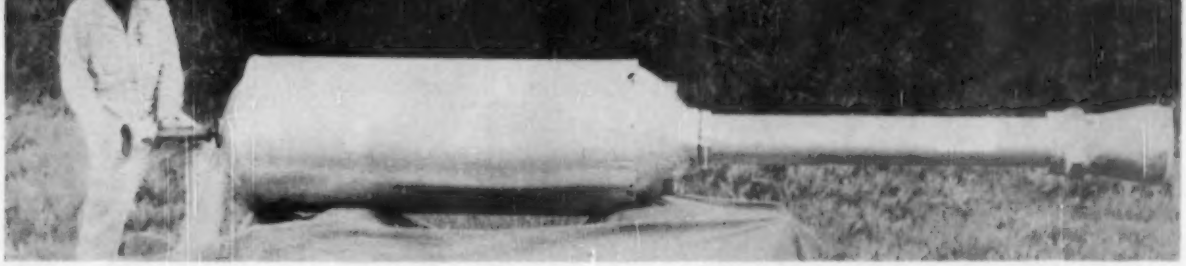
U. S. Army's missile arsenal, designed for air defense and for fighting a limited brushfire type of war, was recently demonstrated at White Sands, N. M. (AW July 7, p. 36). In its first public firing, the Hawk (above) hit a low-flying QF-80 drone at a 5 mi. range and 500 ft. altitude. The proposal above for a Hawk battery emplacement is planned for protection of key U. S. cities and defense areas against enemy air attack. Drawing includes control center, radar tower and radar installation on building, barracks and 12 launcher emplacements covered by domes through which Hawks would be fired, Emplacements would initially be located in New York City and Washington, D. C., to complement Nike defenses. Raytheon Manufacturing Co., prime contractor for Hawk, has been awarded contract to design facilities.

Dart wire-controlled anti-tank missile below hit an M4-A3 tank at a range of 7,000 ft. during the Army's White Sands demonstration. Dart propelled by a dual thrust solid rocket motor, is manufactured by Utica-Bend. Talos (below), Navy-developed ramjet missile, was launched at demonstration from a Talos land-based system delivered by Radio Corp. of America last October to the Army for evaluation. Latest version of Talos is expected to have a range of about 100 mi. Other Army missile systems developments are shown at right.

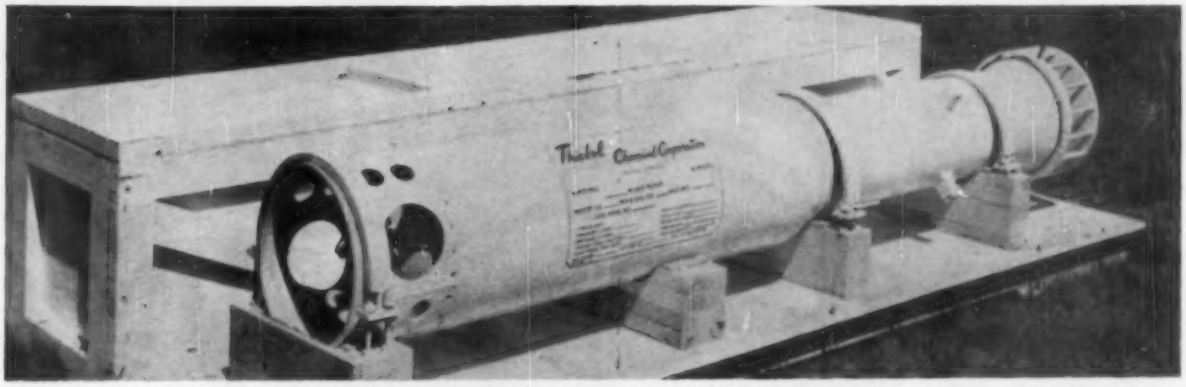


Wire-controlled Dart anti-tank missile weighs less than 100 lb.

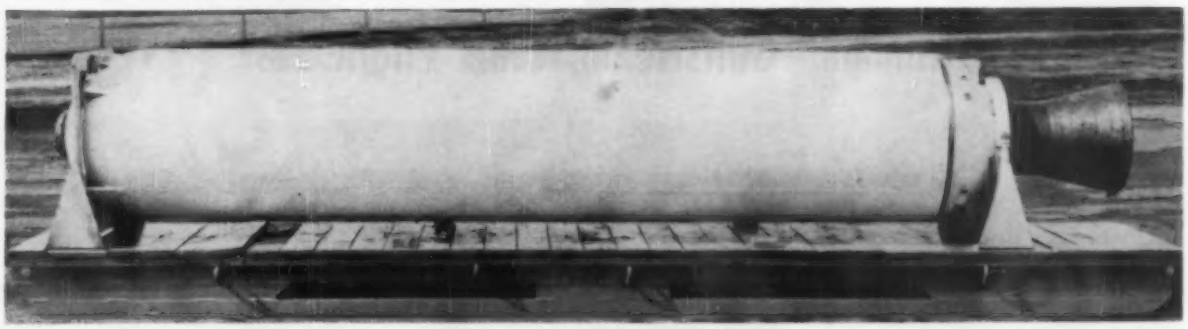
Army's Talos surface-to-air missile is fired at White Sands, N. M.



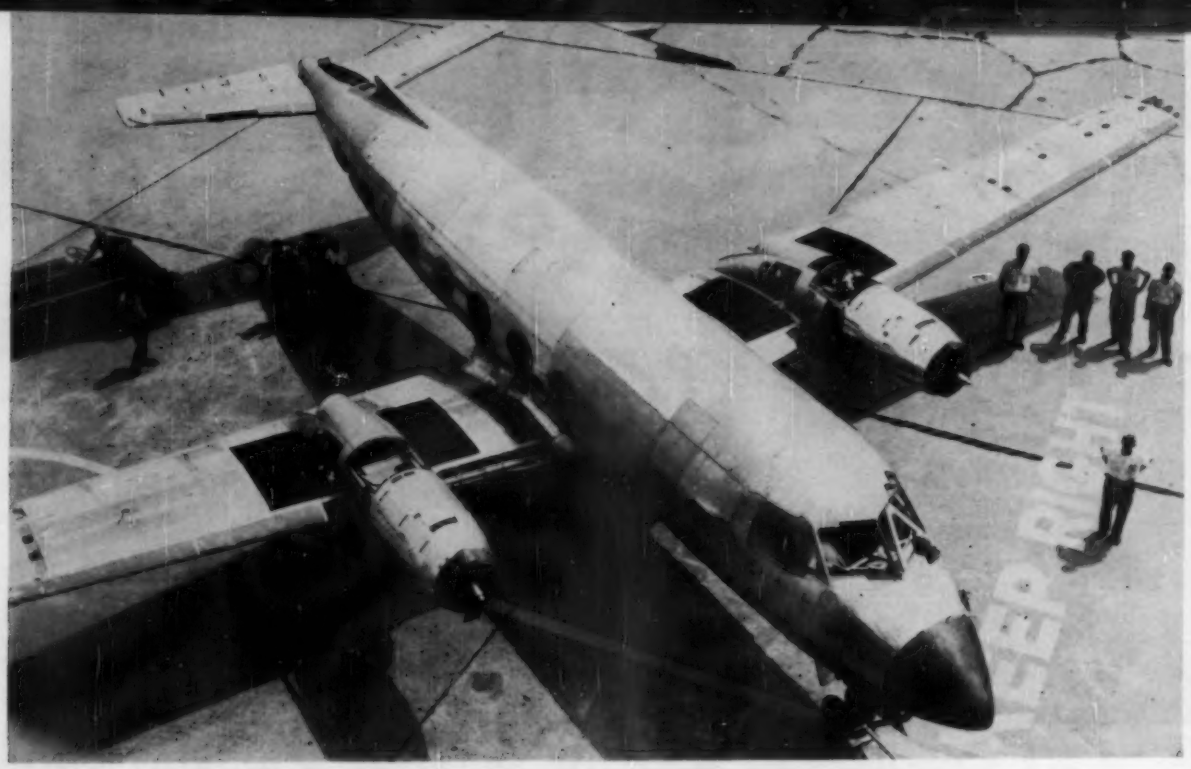
Sustainer unit above for Nike Hercules surface-to-air missile was developed by Thiokol's Redstone Division and Douglas Aircraft Co.



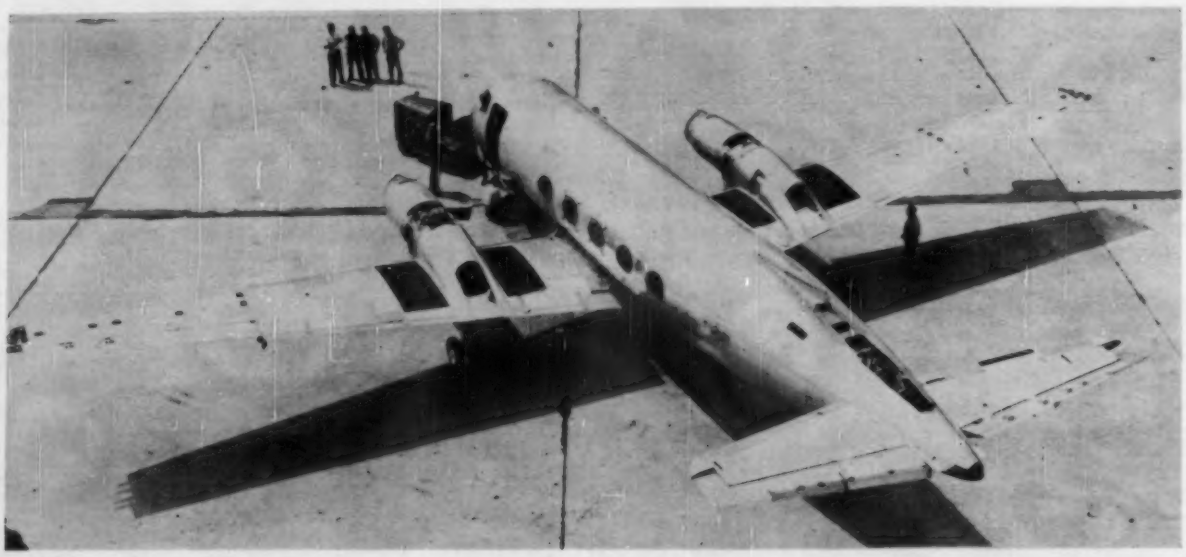
Solid propellant rocket engine above was developed by Thiokol for the Army's Lacrosse surface-to-surface close support missile.



Solid propellant rocket engine (above) for Army's Sergeant was developed by Thiokol Chemical Corp. and California Institute of Technology. Redstone field installation is simulated below by Army's 40th Field Artillery Missile Group at White Sands, N. M.



Grumman Gulfstream Nears Flight Test



Prototype Grumman Gulfstream 10-12-passenger executive transport is moved to final assembly hangar at Bethpage, N. Y., 90% complete, fitted with 2,105 eshp. Rolls-Royce Dart 7 turboprop engines. Flight tests are scheduled to start late this month or early in August. Grumman will keep first two prototypes for tests and demonstration. Company now has more than 25 Gulfstream orders.

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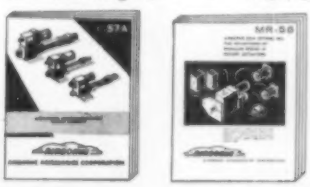

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WHO'S WHERE

(Continued from page 23)

Randal M. Robertson, assistant director for mathematical, physcial, and engineering sciences, the National Science Foundation, Washington, D. C.

James L. Anast, assistant to the president for technical planning (headquarters in Washington, D. C.), Lear, Inc., Santa Monica, Calif.

Wayne A. Proell, division director-research department in charge of work on solid propellants for missiles and jet aircraft, Standard Oil Company (Indiana), Chicago, Ill.

Robert Ford Parker, defense products liaison engineer, Wells Industries Corp., North Hollywood, Calif. Also: **Geery B. Brown**, district manager-Eastern Region (Garden City, L. I., N. Y.)

John F. Burridge, sales manager, and **Richard E. McCormick**, assistant sales manager, Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn.

James E. O'Hara, eastern technical field representative, Voi-Shan Manufacturing Co., Culver City, Calif.

R. L. Burtner, manager-SUBROC project, Goodyear Aircraft Corp., Akron, Ohio. Other SUBROC project appointments are: **A. E. Bjerke**, assistant project engineer; **J. R. Stair**, customer relations; **W. H. Wood**, manufacturing; **W. F. VanBuskirk**, master planning; **J. S. Young**, purchasing; **G. E. Marquis**, quality control.

Richard H. Chamberlin, manager-product design department, Eitel-McCullough, Inc., San Bruno, Calif.

J. S. Dufford, assistant vice president, head of quality assurance and industrial engineering, Apparatus Division, Texas Instruments Inc., Dallas, Tex. Also: **Walton H. Owen**, manager of manufacturing for the division.

Frank Sylvester, foreign sales representative, Lockheed Aircraft Service, Inc., New York International Airport, N. Y.

Dr. Kuang Lu Cheng, associate director of research, Utica Metals Division, Kelsey-Hayes Co., Utica, N. Y. Also: **Dr. Adolph Edward Palty**, supervisor-alloy development and evaluation.

James H. Hedberg, special project engineer, and **Maurice C. Foster**, project engineer, Aerolab Development Co., Pasadena, Calif.

David Demarest, manager-Dayton, Ohio office, American Bosch Arma Corp., Hempstead, N. Y.

Frank H. Bobb, assistant manager-engineering, Beech Aircraft Corp.'s Boulder Division, Boulder, Colo.

W. S. Micchelli, Jr., manager, Navy Inland Missile Test Range, Chance Vought Aircraft, Inc., Dallas, Tex.

Capt. Frank A. Escobar (USN, ret.), assistant to manager, Fairchild Guided Missiles Division, Wyandanch, N. Y.

Harvey L. Hansberry, assistant to the president for flight safety, Fenwal, Inc., Ashland, Mass.

A. W. Orlacchio, chief engineer, Glennite Instrumentation Division, Gulton Industries, Inc., Metuchen, N. J. Also: **Ed Cohen**, assistant marketing manager.

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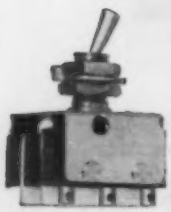
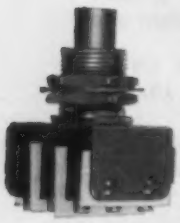


Maintained or Momentary with variations for Single-Pole to Triple-Pole.

	Maintained	Momentary
Single-Pole	A3-20	A3-14
Double-Pole	A3-8	A3-15
Triple-Pole (shown)	A3-27	.....

Bushing size, above models: ¼" x 40. (Also available in 15/32" x 32 bushing.)

Push-Button Actuated Switches



Single-Pole	A4-18
Double-Pole	A4-7
Triple-Pole (shown)	A4-14

Bushing size, above models: 15/32" x 32. (Also available in ¼" x 40 bushing.) Wide Range of Pushbutton Actuators for All Applications.

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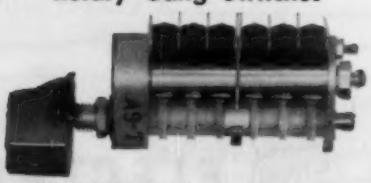

6-Pole assembly A9-7 (shown)
Also available in a wide range of other pole arrangements.

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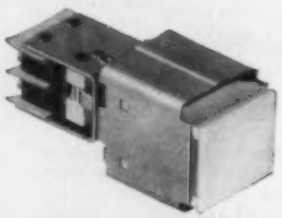

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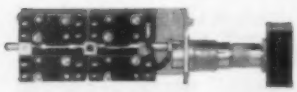
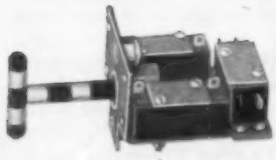
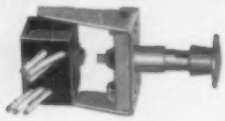


C3-4—Fire Control Switch assures proper sequence during emergency fire conditions. Eliminates pilot error by controlling all functions when single handle is pulled.

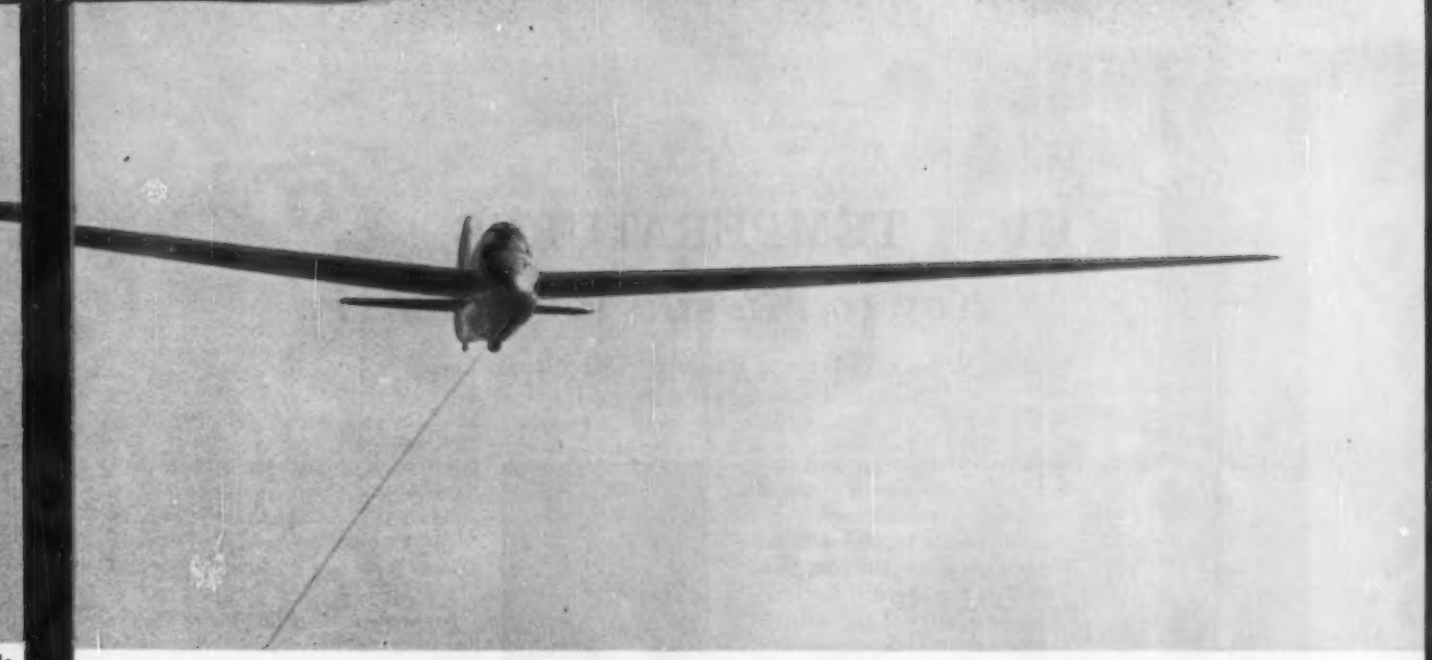


C3-11 — Mechanical override assembly. Will convert from automatic function to manual operation of control surfaces.



C3-8 — Vibration-free, positive detent-action, cut-off switch with potted wire leads in D.P.D.T. with simultaneous action.

C3-13—High current, manually-operated cut-off switch. Will simultaneously interrupt 4 circuits of 40 amps, 30 V DC—or much higher voltages with lower amperages. Has 8 separate circuits available in one control device.



Note that sailplane sits about 10 ft. higher than towplane to avoid propwash. Wing span is 52 ft. 8 in. Glide ratio is 30.5:1.

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is 2.8 fps. Rugged trainer soared at 41 mph.; it was easily spot-landed and stopped in slightly over 100 ft.

• **SGS 1-26.** Single-place medium performance sailplane is small, compact, and sensitive to control pressures. One of the most popular models, it has flown to an altitude of 35,000 ft., over 275 mi. in distance, and close to 8 hr. in duration. Wing span is 40 ft.; wing area 160 sq. ft. Glide ratio is 23:1 Sink speed is 2.5 fps., cruising speed, 77 mph.

• **SGS 1-23G.** Single-place high performance sailplane is all metal, with monocoque type fuselage. Lateral control is excellent. The 1-23 was flown to a world record of 42,100 ft. above sea level, has gained a record 30,100 ft. of altitude and holds a national speed record—43.9 mph.—for 186 mi. over a triangular course. Wing span is 52 ft. 8 in.; wing area is 164 sq. ft. Glide ratio is 30.5:1. Sink speed is 1.9 fps.

Two-Place Trainer

Check flights and first solo were made in the high-wing 2-22C which, along with the 1-26, is being used by cadets at the Air Force Academy. Both of these sailplanes are available in kit form. Tandem-seat trainer, N3891A, sat gracefully on the grass between the hard-surfaced runways at Chemung County Airport. Grass and dirt are best for sailplane landings; there is little scuffing.

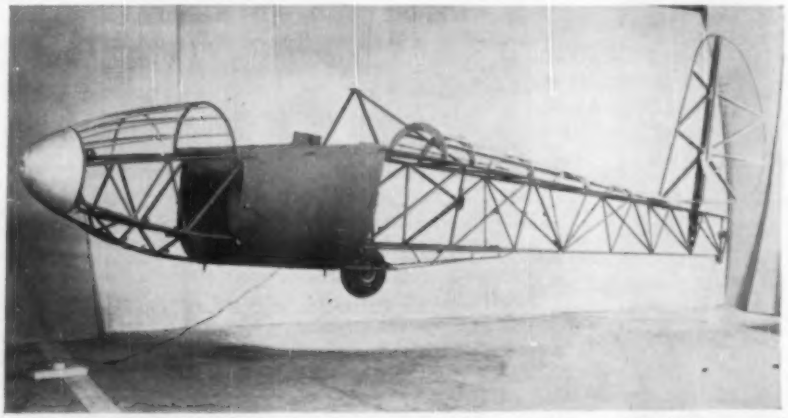
Constructed of welded seamless steel tubing, fabric-covered except for aluminum skin leading edges and tips, sailplane rested on single wheel and wooden wing-tip skid. Wing is single-strut braced; bolt-connected and safetied at fuselage and wing. 2-22's main 6.00-6 wheel sits just aft of the main landing skid. Tire is 4-ply; brake is Goodyear disk. Skid, with steel shoe, is oak wood. Rubber shock mounts sit between skid and airframe. Tail wheel is of hard rubber, 3 in. diameter.

Sailplanes are not exempt from preflight. Controls were checked, along with combined spoiler-brake handle on left side of front panel and tow-line release knob. Two-position bungee handle, on floor, is mechanically connected to stick, lessens control pressure during tow and after release.

Aileron pushrods were checked, as were wiring to control surfaces, jerry struts holding stabilizer, elevator horn and pushrod connections, and spring-loaded tow release.

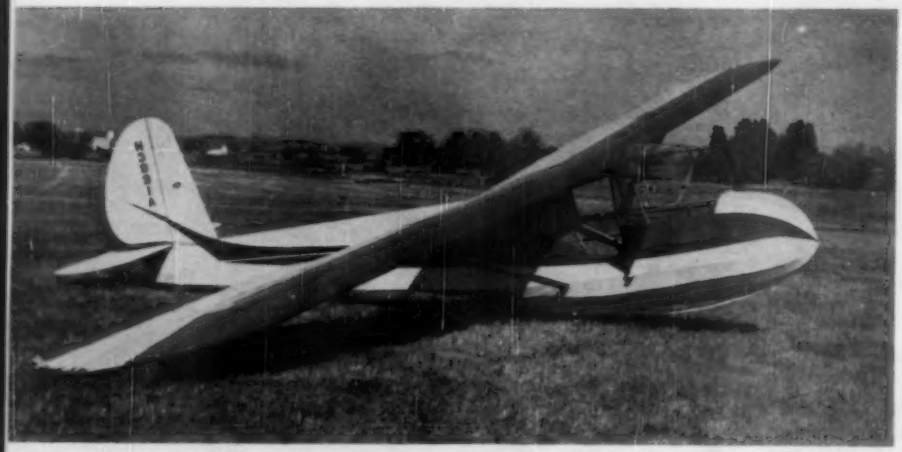
Fully enclosed cabin is comfortable and roomy. Rear door on right side gives access to back seat; canopy swings over from right to left for access to front seat. Trainer instrumentation included Schweizer airspeed indicator, altimeter, and Robinson variometer (used to detect upcurrents and sensitive to small rates of climb).

Seat belts and shoulder harness were

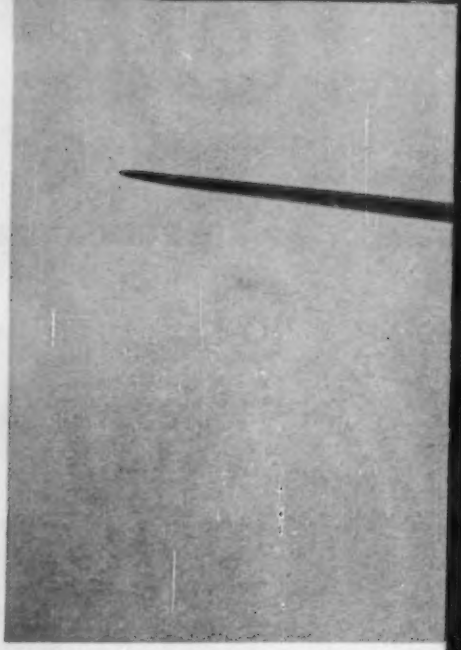


FUSELAGE of the SGS 1-26 is of welded chrome-moly steel tubing, will be fabric covered except for cockpit, which is covered by 24 ST aluminum skin of .051 gage.

TWO-PLACE, high-wing 2-22C trainer (above, during takeoff, and below) has wing area of 210 sq. ft., glide ratio of 18:1. Struts are bolt-connected and safetied at wing and fuselage. Skid is of oak, with steel shoe. Flying speed averages about 40-45 mph.



SINGLE-PLACE, medium-performance 1-26 sailplane (below) has wing span of 40 ft., wing area of 160 sq. ft. Glide ratio is 23:1. Stall speed is 26 mph. Wing dihedral is 3.5 deg. Twist from root to tip is 2.5 deg. Plexiglas canopy affords excellent visibility.



SCHWEIZER 1-23 sailplane is towed to altitude.

Aviation Week Pilot Report

Sailplanes Gain

By Robert I. Stanfield

Elmira, N. Y.—Low operating cost, learning ease and safety of the modern sailplane have encouraged increasing participation in a sport-art-science that is a challenge both to the beginner and to the licensed glider or airplane pilot.

Soaring is attracting a gradually widening circle of adherents. Most beginners find it a natural and relatively inexpensive springboard to powered flight and the study of aerodynamics. It's the closest thing to "making like a bird" and the more skillful the pilot, the farther, the higher and the longer he can fly.

Efficiency of today's sailplane is keyed to its high gliding ratio, speed and low sink rate. For the licensed pilot the initiation is quick.

Soaring in production models of the Schweizer Aircraft Co., this AVIATION WEEK editor completed the professional power pilot course at Schweizer's Soaring School in Elmira, N. Y., in two days. Result: a commercial glider rating, the Federation Aeronautique Internationale "C" soaring award, and a healthy respect for the balance, stability and maneuverability of these three sailplanes:

• **SGU 2-22C.** Two-place high-wing trainer showed excellent control on the ground, during airplane and winch tow, and at low flight speeds. Wing span is 43 ft.; wing area is 210 sq. ft. Glide ratio is 18:1. Sink speed, solo,

used in all gliders flown. Tow line, about 240 ft. long, was ¾ in. manila rope. It is hooked up to towplane only after pilot is adjusted in cockpit. This is to prevent an empty sailplane from being towed off.

Wind was from the northwest at 5 to 10 kt. when our towplane—a 150 hp. Piper Super Cub—taxied up and we hooked on. Airplane slowly moved out straight ahead, parallel to runway, until slack had left line. Team-man held up the wing and we were sitting level.

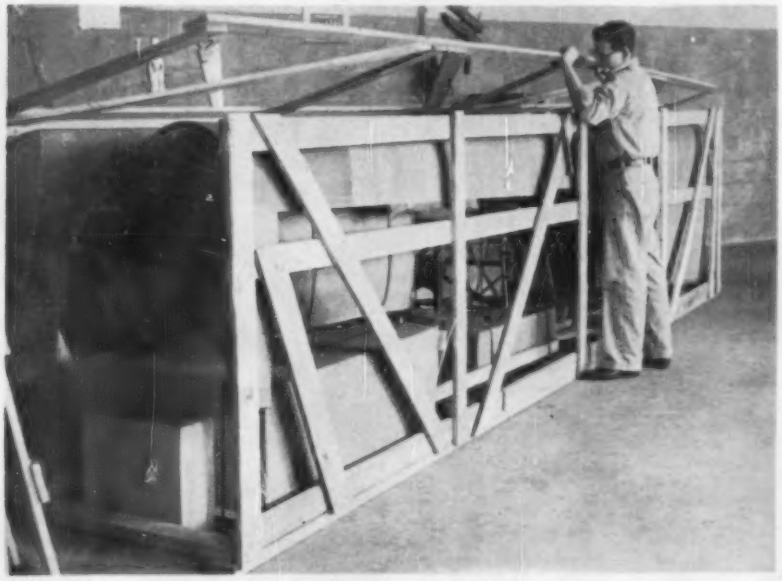
Bernard M. Carris, chief Schweizer instructor, checked me out on all phases of flight. Carris, who holds the FAI Silver "C" award, and has completed his distance and goal legs for the Gold and Diamond "C," nodded an "OK" to the wing man, who waved up to the towplane pilot. With an answering waggle of towplane rudder we were off.

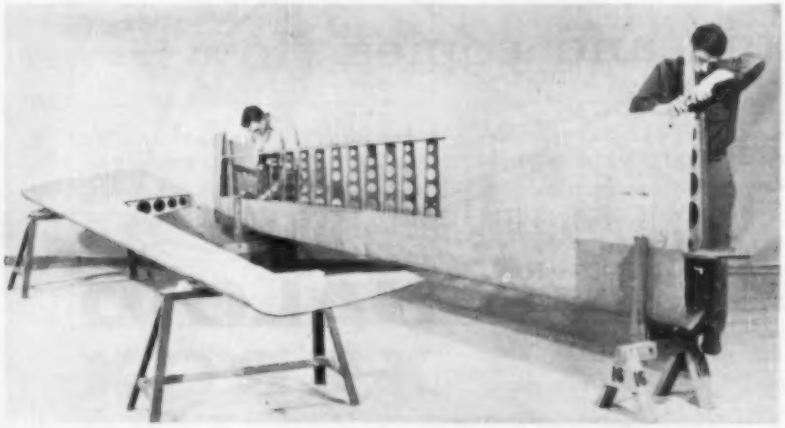
2-22 lurched forward on the skid and with slight back pressure was running along on wheel. In about 200 ft., the trainer was airborne and whistling along behind the towplane. Forward pressure was necessary to hold trainer close to ground. Too steep a sailplane takeoff could pull up tail of towplane, which itself was not airborne until it had run about 500 ft.

Excellent Control

Control was excellent during takeoff and climbout. 2-22 was held 10 ft. above the towplane, out of propwash; speed throughout tow was 55-60 mph. Should the airplane have aborted, trainer easily could have slipped in ahead or, once a few hundred feet of altitude had been gained, a 180 deg. turn back could be made.

During slow climb to altitude, attempt was made to coordinate sailplane's movements with that of towplane. Getting too far inside on a turn could result in a slack rope. Too much slack would mean a sharp jerk as rope takes up, and a possible break. Too far





COMPLETE 1-26 sailplane kit, above, weighs about 700 lb. Novice can complete standard kit in less than 500 manhours time. Below, work on wing from 1-26 kit.

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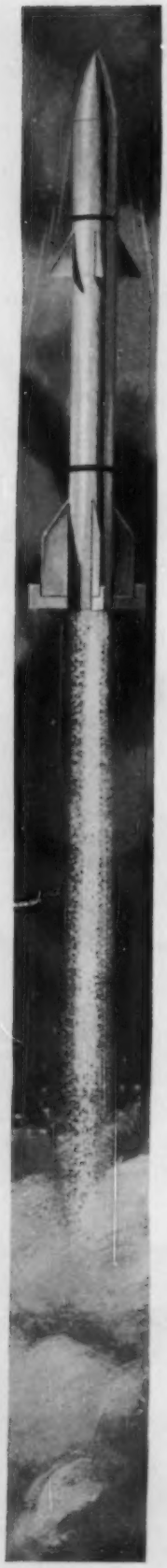

HIGH TEMPERATURES
Key to Missile Performance

by John V. Long, Director of Research, Solar Aircraft Company

HIGH TEMPERATURE presents a formidable barrier to the advancement of missile technology. Present defense requirements call for temperatures ranging from —460F to way beyond the limits of known material capabilities. New and planned developments in atomic power and space flight will mean temperature levels far outside of man's current experience.

The temperatures encountered in missile development produce startling phenomena. They are part of today's problems—affecting the very concept of the new generation of high-Mach aircraft and missiles. Laboratory experiments have produced temperatures in the million degree range. Nuclear fission and fusion reactions produce temperatures even higher.

In the all out attack on the thermal barrier, scientists and material researchers are probing the four corners of the periodic table. The goal is to develop a practical solution to the thermal problem.

The highest melting material reported is a combination of the carbides of tantalum and hafnium. Its melting point is about 7200F. Difficulty of fabrication, however, precludes its use in present day applications. And 7200F is at the cold end of the high temperature spectrum. It is obvious, then, that a solution to the materials problem cannot be based on melting point alone. Man will never beat the thermal thicket by hitting it head on. Success will come only when he has devised new methods of ingeniously avoiding it.

There is an immediate need for a combination of materials and designs which will withstand temperatures of 2000F in jet engines —and at least 20,000F for re-entry vehicles.

In an all-out effort to satisfy some needs, materials researchers are re-evaluating available elements, combinations and processes. New techniques including vacuum metallurgy, zone refining, powder metallurgy, dispersion hardening and others are providing improved metals and alloys. Molybdenum, tantalum, rhenium and tungsten show promise because of their high melting points. But no known material has the refractory property or structural integrity to withstand the temperatures that will be encountered in tomorrow's "hotspeed" aircraft and missiles.

Extreme temperature resistance is not just a materials problem, but a problem of interaction between environment and the material of the vehicle. Designers must look at the system as a whole and design "around" high temperature problems. The use of heat sinks, ablation and transpiration cooling are partial solutions. Additional improvements will come with more research.

For the present we must learn to use available materials and, through design, provide the balance of the solution. We have by no means exhausted present material capabilities. Researchers must continue to refine and extend the high temperature performance of a variety of materials.

A comprehensive knowledge of both metals and non-metals and their physical characteristics in extreme environments is necessary for successful applications. The ability to fabricate useful structures is obviously a major criterion.

Best results will be obtained through a materials systems concept. This involves close coordination among raw materials suppliers, users, materials engineers, designers, test engineers, fabrication specialists and quality control engineers.

The team effort must be enthusiastic—and it must be dedicated to ultimate success through hard work.

Solar's capabilities are centered in a team of experts experienced in the many sciences related to missile and systems technology—from basic design to highly precise experimental, prototype and volume production. This backlog of experience is available for your important missile program. For information, write to Dept. F-44, Solar Aircraft Company, San Diego 12, California.

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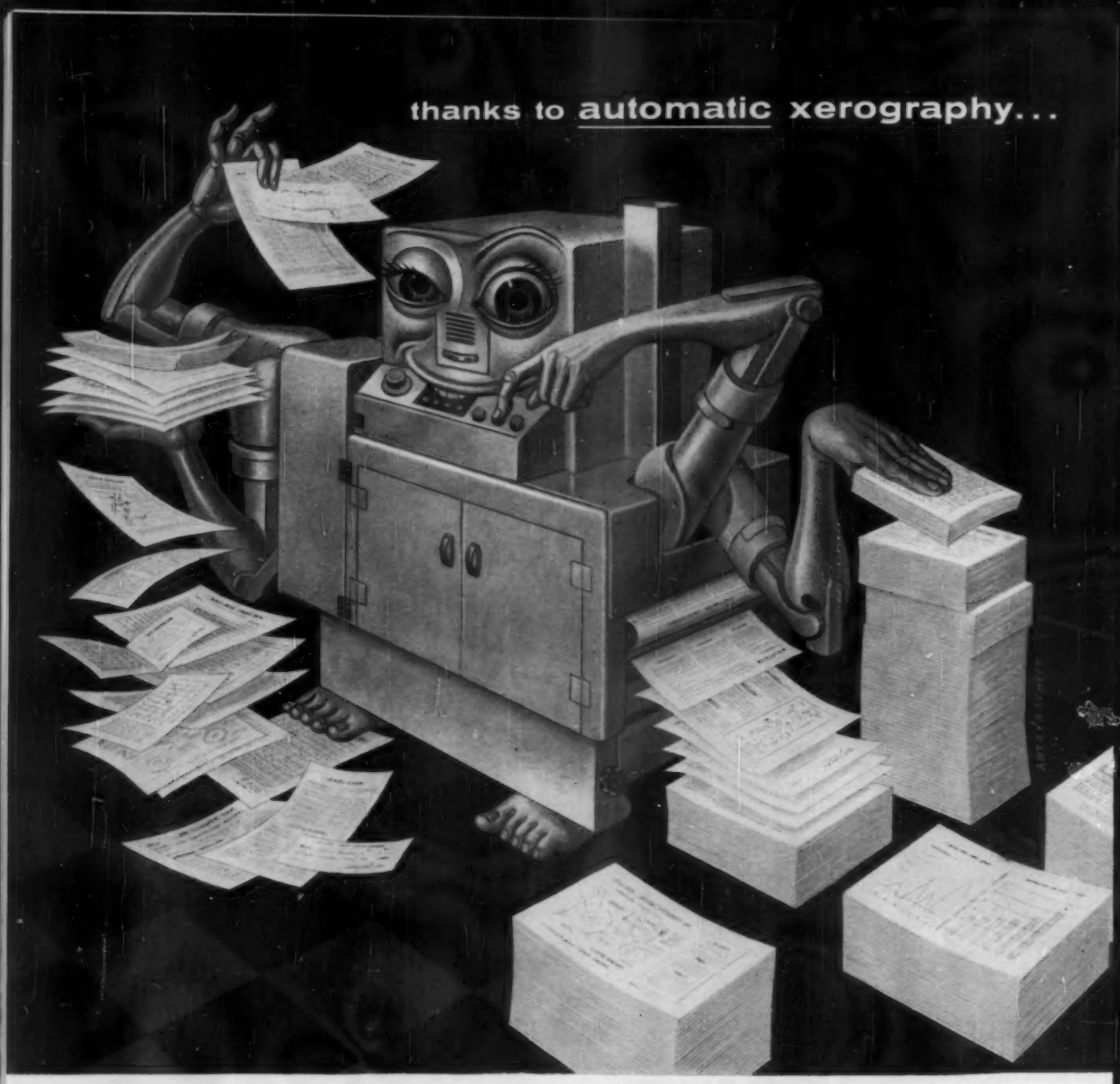

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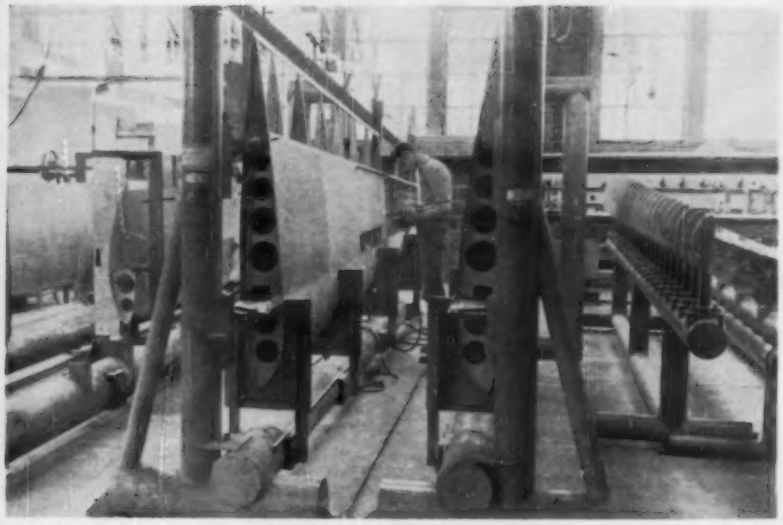


WING FIXTURES of 1-26 in production jigs. In building sailplane from kit package, jig form is not necessary. Note wing panels for upcoming 1-29 at left.

outside could mean too tight a rope, greater speed for the sailplane and a resulting "kiting" up.

First flight was made to 3,000 ft. where standard right-hand break was initiated after release. Speed was reduced to about 41 mph. and almost effortlessly we soared about. A few 360 deg. turns were made; 2-22 didn't lose 100 ft. altitude. In tight turns more rudder was used than would be held in an airplane, but airspeed does not build up.

Control was excellent. Elevator travel is 25 deg. up, 21 deg. down. Rudder moves 30 deg. left or right. Ailerons travel 38 deg. up, 21 deg. down.

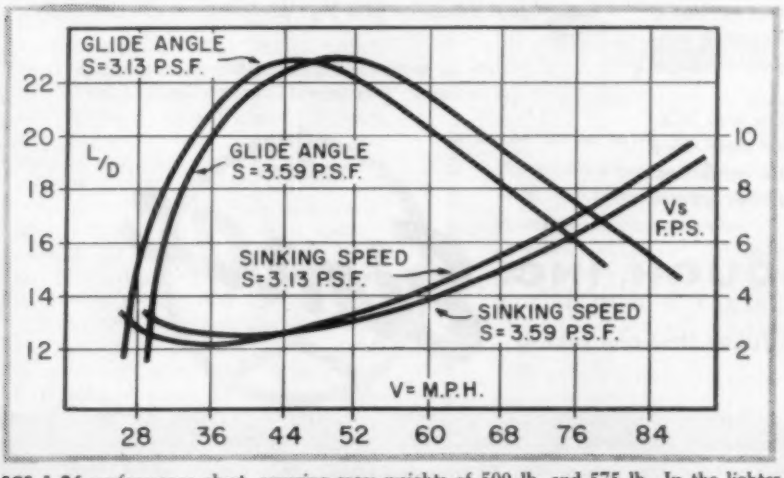
Sailplane was stalled both at slight and steep angles of climb. There was no falling off of wing, no tendency to spin out. In each case, at just over 30 mph., nose fell straight ahead. Clean design gives fast pick-up of speed, and soaring was resumed with a negligible loss of altitude.

Design of 2-22 negates wing-tip stalls. Wing dihedral is 1.5 deg. There is 4 deg. incidence at root; 1 deg. at tip. Washout is 3 deg.

Good Visibility

Large Plexiglas area afforded good visibility in all the sailplanes. There is no vibration. But the quietness, except for the whistling through the air, is at first startling. At one point I heard a twin transport taking off from the airport below before I saw it.

Part of the skill of soaring comes with finding a thermal and climbing on up. Pilot can feel the rise, which also will show on variometer. Then comes the attempt to hold it; it's very



SGS 1-26 performance chart, covering gross weights of 500 lb. and 575 lb. In the lighter configuration, normal wing loading is 3.13 psf. Maximum, for 575 lb., is 3.59 psf.

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SGS 1-26 Specifications

Wing span	40 ft.
Length	21 ft. 3 in.
Height	7 ft. 2.5 in.
Wing area	160 sq. ft.
Aspect ratio	10
Min. load factor	8.31
Empty weight	348 lb.
Max. gross weight	575 lb.
Normal wing loading	3.13 psf.
PERFORMANCE	
Airplane tow	95 mph.
Auto-winch tow	60 mph.
Spoilers extended (max.)	104 mph.
Stall speed	26 mph.
Placard speed	104 mph.
Cruising speed	74 mph.
Min. sink speed	2.5 ft. per sec.
Gliding ratio	23:1

easy to fly in and out. Thermals move with the wind. I did best, on later flights, with a continuing moderate 360 deg. turn, which would send sailplane up in spurts.

The first time up I didn't do too well, despite some figure eights over the adjacent ridge, source of upcurrents. At about 700 ft. above valley and airport level, 2-22 was angled back for landing.

Spot Landing

With knack acquired after a flight or two, sailplanes can be spot-landed with little effort. The trick is to avoid undershooting by an approach on the high side, then dropping spoilers.

Downwind approach was made at 45 mph. Turning onto base leg, 2-22 was slightly high—300 ft. Here's where spoilers were used. Trainer's spoiler area is 1.5 sq. ft. Travel, from top of wing, is 75 deg. up. Pulling out spoiler-brake knob activates spoilers to any degree; all the way out, internal brake is set and landing roll is minimized.

Spoilers can result in rate of sink five times greater than normal. In the trainer, rate is about twice normal. Nose dropped a bit, and 2-22 seemed to float down. Spoilers were then raised, and sailplane scooted ahead; dropped, and trainer settled gently. In this manner one can spot-land with little difficulty.

Sailplane was landed on skid-wheel, nose not too high to avoid tail-first contact. At about 35 mph., with brake on, 2-22 swished through grass and was stopped in slightly over 100 ft.

From here on, in all towplane take-offs were to 2,000 ft. First few check rides averaged from 15 to 20 min. each. First solo in trainer, with decrease of weight, ran 26 min.

Mid-wing, single-place streamlined 1-26—N3812A—was brand new—Serial No. 83. Bubble-type Plexiglas canopy

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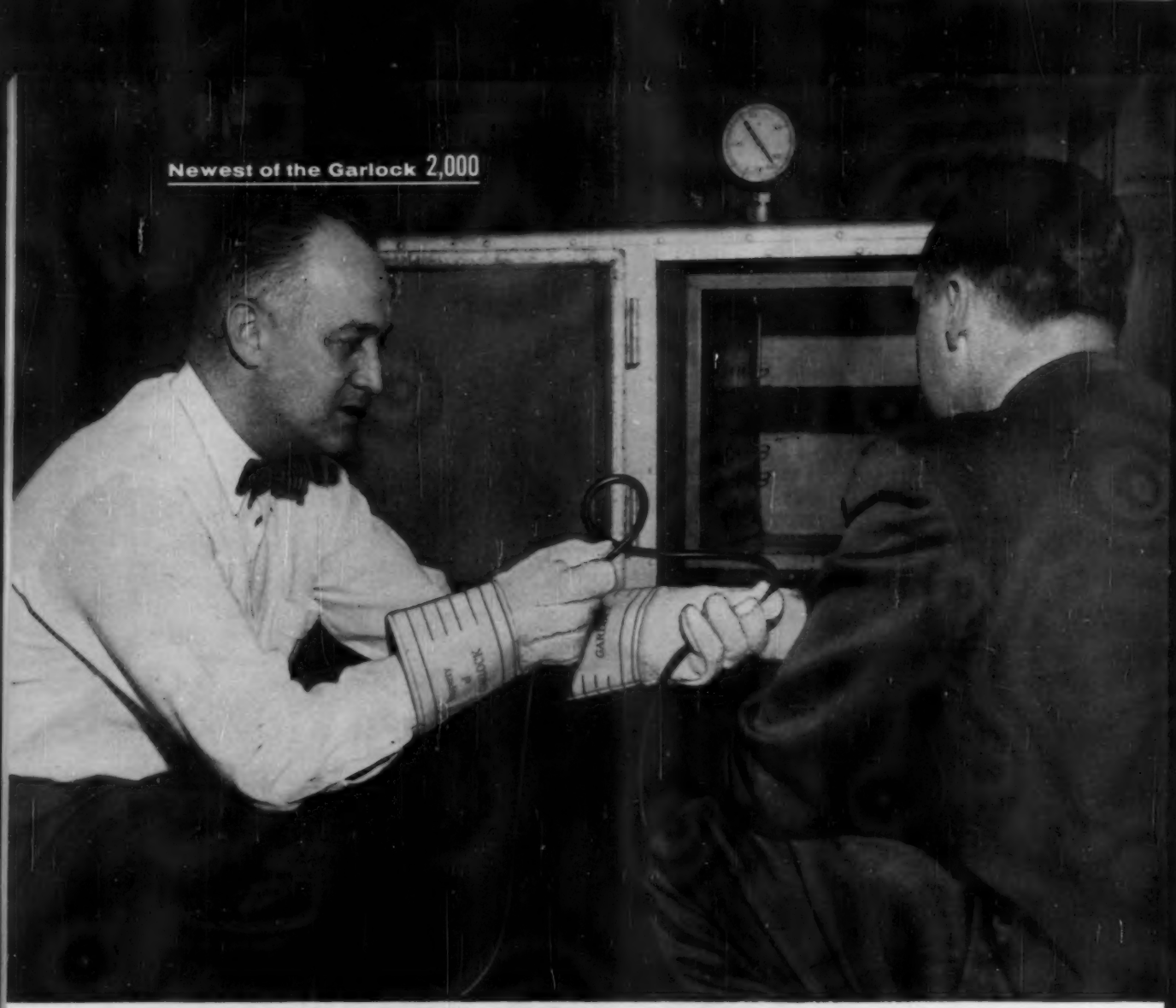

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SGU 2-22C Specifications

Wing span	43 ft.
Length	25 ft. 8.5 in.
Height	9 ft.
Wing area	210 sq. ft.
Aspect ratio	8.81
Empty weight	450 lb.
Gross weight	900 lb.
Wing loading	4.28 psf.
Horizontal tail area	20.51 sq. ft.
Vertical tail area	13.04 sq. ft.
Aileron area (two)	19.46 sq. ft.
Performance:	
Level flight high speed	89 mph.
Airplane tow	89 mph.
Auto-winch tow	66 mph.
Spoilers extended (max.)	90 mph.
Stall speed, solo	28 mph.
Stall speed, dual	31 mph.
Gliding ratio	18:1
Sink speed, solo	2.8 ft. per sec.
Sink speed, dual	3 ft. per sec.

hinges on left side and is swung over for pilot access to cockpit. Instruments included airspeed, altimeter, rate of climb and variometer.

This model has been featured in "one design" sailplane meets, wherein all contestants used same type sailplane. Fuselage is welded chrome-moly steel tubing. Aluminum skin covers root section and tips of wings. Intermediate section and trailing edges are fabric covered, as is fuselage except for cockpit which is of 24 ST aluminum skin of .051 gage.

Flight was made via towplane, and sailplane was cut loose at 2,000 ft. Medium-performance 1-26 is very sensitive to light control forces. Stall speed is 26 mph. Wing dihedral is 3.5 deg. Angle of incidence is 4 deg. at root, 1.5 deg. at tip. Twist from root to tip is 2.5 deg. Aileron control at or near stall is excellent. Elevator travels 25 deg. up or down. Rudder travel is 30 deg. left or right. Aileron movement is 36 deg. up, 18 deg. down.

Airspeed during search for thermal was 40 mph. S-turning over ridge hadn't produced any appreciable uplift and altitude had dropped to 1,700 ft. when I hit a good thermal. Highly maneuverable 1-26 can do an "about face" if necessary. Sailplane was held in tight turn and reached altitude of 4,000 ft. in about 6 min.

Speed during ascent dropped below stall minimum several times as attempt was made to "horse" 1-26 up. Sailplane has good spiral stability. There was no tendency to go "over the top." Speed built up the instant nose was dropped. Best 1-26 airspeed in thermal is 45 mph., but with tendency to yank sailplane up major portion of climb was at 35 mph.

1-26 flight lasted 1 hr. 15 min. Sailplane didn't want to come down; spoilers were used to drop to pattern altitude. Spoilers on this model extend 80 deg. upwards, are quite effective.

While sailplane is adapted to small landing area, pilot must curb "wandering" tendencies during local flight. Should he stray too far, and lose his thermal, he may not make it back. Result: a trailer pickup and an embarrassed pilot.

Approach in 1-26 was made at 50 mph. Added speed at low altitude is safety factor against down drafts. Sailplane was brought in high, from 400 ft. on base leg, and spoilers raised for a spot landing. 1-26 was on the ground and stopped in 100 ft.

In addition to the airplane tow, there are other means of getting a sailplane into the air: auto towing, shock-cord catapult and winch tow. Latter two are particularly adaptable to small areas and ridges.

Two winch-tow releases were made from Elmira's Harris Hill, with the 2-22C. Hill overlooks valley and the county airport, which it tops by 800 ft. (Height above sea level is 1,700 ft.).

Trainer faced west, into gusty wind of 15 kt. Manila rope, ½ in. diameter, stretched some 1,500 ft. from winch drum to sailplane release. Slack was taken up and 2-22 was ready for takeoff.

In winch tow, engine-driven drum winds up rope and quickly accelerates sailplane to flying speed. Towing is smooth and sailplanes can be climbed to 1,000 ft. in this manner.

The 2-22 got off to a good start, airspeed jumping to 55 mph. soon after it was airborne. Gradual rate of ascent was made until slightly over 100 ft. of altitude was gained, then 2-22 was pulled up steeply. Altitude of 400 ft. was reached when tug of played-out towline was felt, and sailplane was immediately leveled off and towline released. 2-22 was over valley, and after a bit of ridge soaring was landed on hill for another go-around.

There is little chance for a snag in release during winch tow but, should it occur, a guillotine-type cut-off device attached to winch will quickly sever rope.

Schweizer's single-place high-performance 1-23, with canopy similar to 1-26, had fairly complete instrumentation: magnetic compass, turn & bank, clock, airspeed, Robinson and Cosim variometers, rate of climb, altimeter, free air temperature gage, plus nose trim, pitot tube and cabin vent.

Oxygen and radio equipment are almost a must, for this sailplane is capable of high-altitude and far-ranging flight. Wing span is 52 ft. 8 in. Empty weight is 479 lb., gross, 750 lb. Length is 20 ft. 9 in.

Flight in the 123-G, N91897, was

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Write today for this interesting booklet about Librascope.

made via airplane tow to 2,000 ft. Sailplane showed excellent aileron control and maneuverability, and I ridge-soared for about 35 min. with little effort. Wing root angle of incidence is 4 deg. Twist is 2.5 deg.

1-23 is redlined at 119 mph. for glide or dive and 110 mph. for airplane tow; 68 mph. for auto-winch tow. With spoilers extended to maximum of 80 deg., airspeed limit again is 119 mph. Elevator movement is 25 deg. up or down; rudder, 30 deg. left or right. Ailerons move 36 deg. up, 18 deg. down.

Sailplane is quite sensitive to spoilers and despite increased approach speed—ours was 60 mph. because of gusts—was easily slowed down coming over the fence and, with full spoilers applied, can be settled in neatly and quickly. Release the spoilers on roundout and sailplane takes off fast.

Schweizer is also developing new all-metal high performance sailplane, 1-29, with laminar flow wing. Sailplane will utilize 1-23 fuselage. Glide ratio is expected to be over 40:1. Model will be available in early 1959.

Soaring Methods

Soaring can be accomplished anywhere in the country. Here are some varied ways of gaining and holding altitude, and going places, the first two of which I used at Elmira:

• **Dry thermals.** Rising ground temperature, usually from ground heated by sun. Best thermal results are on calm days; winds are prone to disperse thermals. Ploughed fields are good bets. Up high, soar downwind from field.

• **Slope winds.** Extended, wide ridges are most favorable for slope currents.

• **Cumulus clouds.** Here upcurrents are intensified by heat of condensation. Lift will be found windward of cloud; the lower under the cloud, the farther upwind the thermal.

• **Bishop wave.** Condition exists at Bishop, Calif., where many records have been set. Extremely turbulent air, running over Sierras from Pacific, builds up successive rolls of air on leeward side of range. Upward branches have strong vertical velocity.

• **Fronts, thunderstorms.** Upcurrents are strong. Cold air flowing over warm ground makes for good soaring condition. But it's best to stay ahead of thunderhead.

There were two pilots who soared into a cumulo-nimbus. One aircraft was thrown out at some 20,000 ft. after probably having ascended at up to 50 ft. per second. In the other instance sailplane was whirled about and pilot could do little to stop it. He crashed in heavy rain, in downdraft, with sailplane moving sideways. Pilot was lucky to walk away.

Both the 2-22 trainer and the 1-26 are produced in varied degrees of CAA-approved kit form, and complete. Breakdown follows for both:

• **Dry kit.** Standard kit less covering, fabric, finishing materials, wood. $1,995 for 2-22; $1,595 for 1-26.

• **Standard kit.** Complete materials and fabricated parts. Fuselage completely welded. This is most popular kit. Novice can complete in about 500 manhours, A&E licensee in 300 manhours. Only items not furnished are instruments, seat belts and shoulder harness. $2,145 for 2-22; $1,655 for 1-26.

• **Unit purchase plan.** Kits are divided into individual units, four for the 2-22 and five for the 1-26. Units consist of left and right wings, fuselage, surfaces, finishing materials, etc. Purchaser may order one or more of units until complete kit is purchased. $2,315 for 2-22; $1,825 for 1-26.

• **Uncovered sailplane.** All structural work complete. Fairing, covering, canopy to be done by purchaser. All materials furnished except instruments, seat belt and shoulder harness.

• **Complete sailplane.** Ready to fly, including seat belt, shoulder harness, airspeed indicator, altimeter, variometer with 2-22. $3,250 for 2-22; $2,995 for 1-26.

Weight of the 2-22 kit is about 1,200 lb.; that of the 1-26 is about 700 lb.

All-metal 1-23 is complete. With two-tone enamel finish, cost is $4,995. Less finish, but primed, cost is $4,695. Standard instrumentation includes airspeed indicator, Robinson variometer and sensitive altimeter. Crated sailplane weighs approximately 1,000 lb.

Tool Requirements

Schweizer also manufactures trailers for all sailplanes, cost varying from $450 minus tires for the 1-26, to $520 complete for the 1-23. In addition to common tools necessary for kit construction, essential tools would include drills, extension drills, valve guide reamers, hand rivet sets, bucking bars, hand reamer and chip chaser. Firm rents specialized kit at $11.50 per month.

Two men can dismantle or assemble sailplane for trailer transportation in 20-30 min. Six bolts—three for each side—are removed to pull wings. Horizontal surfaces—involving removal of four bolts—are dismantled only for the long haul of a few thousand miles.

To date Schweizer has sold 58 2-22s, 85 1-26s and 36 1-23s. Firm has built 10 of the former this year, holds three-to-five ship backlog. The 1-26 is built in lots of 25; sells about one every two weeks. The 1-23 is built in lots of five; at this writing three are committed. Foreign purchasers include Canada, which has bought seven 1-26s, and Venezuela, which purchased 10 2-22 kits. Dealers now number 14 and will

increase with expanded activity. Up until a few years ago soaring in the U.S. was the sport of the glider pilot. Today there is a movement by rated airplane pilots toward becoming glider pilots.

Last year there were close to 4,000 licensed glider pilots in the U.S. Number of sailplanes in operation totaled 481, including many war surplus. There were 85 soaring clubs and over 2,000 members of the Soaring Society of America, U.S. representative of the Federational Aeronautique Internationale for motorless flight through the National Aeronautic Assn.

Four-man SSA team recently competed in the biennial World Soaring Contest at Leszno, Poland. Because of lack of funds, U.S. team flew borrowed sailplanes of European make. Lyle Maxey, of the American team, placed ninth in the unlimited class.

CAA pilot certificates for glider ratings require no physical, though applicant must certify that he has no defects that would render him incompetent to pilot a glider. Student rating can be acquired at the age of 14; private at 16 and commercial rating at 18. Power pilots may obtain rating with 2 hr. of glider time, including 10 flights, and passing flight test.

At Elmira, package courses for glider ratings run from $85 for power pilots (commercial), $125 for power pilots (private) to $350 for those with little or no flying experience. Dual flights in trainer run $10 per hr., solo in the 2-22 or 1-26 costs $6 per hour. Airplane tow launchings run $3 for first 1,000 ft.; $1 for each additional 1,000 ft.

Helicopter Autopilot

Autopilot functions for helicopter are provided on this Sikorsky HSS-1N by auto stabilization equipment mounted on cyclic stick (between pilot's knees). Unit provides "hands off" characteristics; when aircraft is flown manually, ASE makes the necessary automatic corrections.

ENGINEER OPPORTUNITIES AT RAYTHEON

ARMY'S HAWK MISSILE is launched from mobile platform by fast-moving land forces. Raytheon engineers working on prime contract developed the design that makes possible missile's extremely low-altitude capabilities.

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Before you make your next move, you'll want to take a long careful look at the leading companies in missiles and where they are heading. Your company list will include Raytheon —now prime contractor for the Army Hawk and Navy Sparrow III, with *continually expanding* development programs that need the talents of capable men in:

STRUCTURES: Stress analysis • Structural design • Dynamic analysis • Static testing • Weight analysis

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For interview in Bedford, Mass., please write, wire, or phone collect to CRestview 4-7100. Ask for R. W. McCarthy.

RAYTHEON MANUFACTURING COMPANY

RAYTHEON
MISSILE SYSTEMS DIVISION
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WINGS of Klemm Kl.107B can be detached, mounted along sides of aircraft for transport. Split flaps are operated by hand.

K1.107B Enters Business Flying Market

Hanover—The Klemm Kl.107B executive airplane featured at the recent German air show here is aimed specifically at the business market.

The current model was flight tested last summer and the first production series is now being assembled at the Böblingen works (AW May 26, p. 111).

The light plane was designed as a joint venture by Ludwig Bölkow of Bölkow-Entwicklungen, K.G., of Stuttgart, and Hanns Klemm of the Klemm-Flugzeuge GmbH., of Böblingen. It is a modified version of its predecessor, the Klemm Kl.107A, first trial model of which was introduced at the end of 1956.

Klemm Kl.107B is a multi-purpose, single-engine, three-seat lightplane of semi-monocoque wood construction. It has a large cabin, two doors opening forward, the usual lightplane instrumentation and radio installation. The two front side-by-side seats are adjustable on the ground and can be designed to accommodate parachutes. The third seat is behind the pilot. There is also a large baggage compartment. The plane has removable dual controls, and the rudder pedals can be adjusted during flight. Ventilation and heating are provided for.

Single-Spar Design

Aircraft has a low cantilever wooden wing of single-spar design with fabric-covered trailing edge section. The wings are detached and mounted along the fuselage sides for transport. Hand-operated split flaps are provided.

Fixed single-leg undercarriage is attached to the fuselage using a shock absorber designed to require minimum maintenance—the strut can be faired, if desired. The brakes are operated hydraulically from the pedals. The steerable tail wheel is on a shock-absorbing strut.

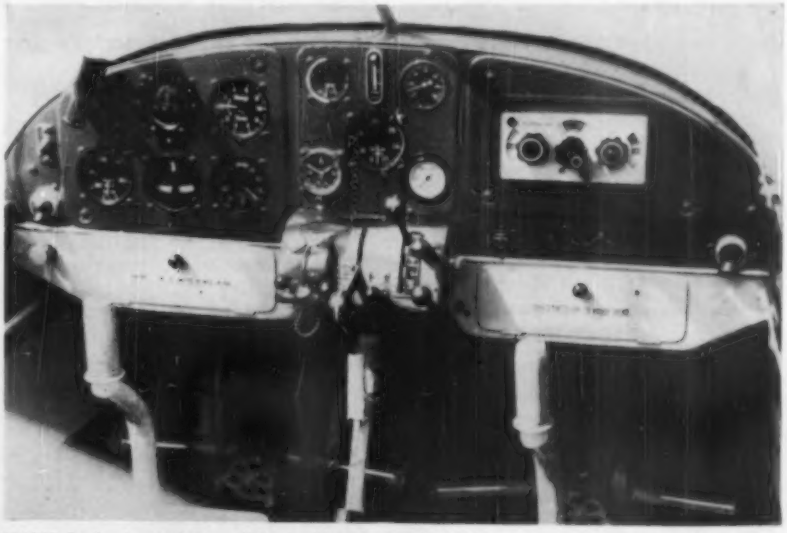
The tail unit is of plywood-covered wood construction. The control surfaces with mass balance are fabric-covered. The controls lock automatically when the cabin is locked from the outside.

The aircraft is fitted with a single 150 hp. Lycoming engine and has an oil cooler, fire extinguisher and an electric starter. Fuel tank capacity is 26.4 gal.; reserve tank, holds 6.6 gal.

There are three and two seat versions

Klemm K1.107B Specifications

Span	36.9 ft.
Length	26.6 ft.
Height	9.7 ft.
Wing area	157 sq. ft.
Empty weight	P3: 1,257 lb.
	S4: 1,257 lb.
Load	P3: 816 lb.
	S4: 573 lb.
Total weight	P3: 2,072 lb.
	S4: 1,830 lb.
Wing loading (S4)	11.47 lb./sq. ft.
Top speed	188 mph.
Cruising speed	133 mph.
Landing speed (S4)	43.5 mph.
Sea level climb (S4)	885.6 ft./min.
Service ceiling (S4)	about 17,500 ft.
Fuel consumption	8.2 gal./h.
Range	466 m.



HAND brake (center) is used for parking; hydraulic brakes are operated from rudder pedals.

Trevarno makes it tougher than you think

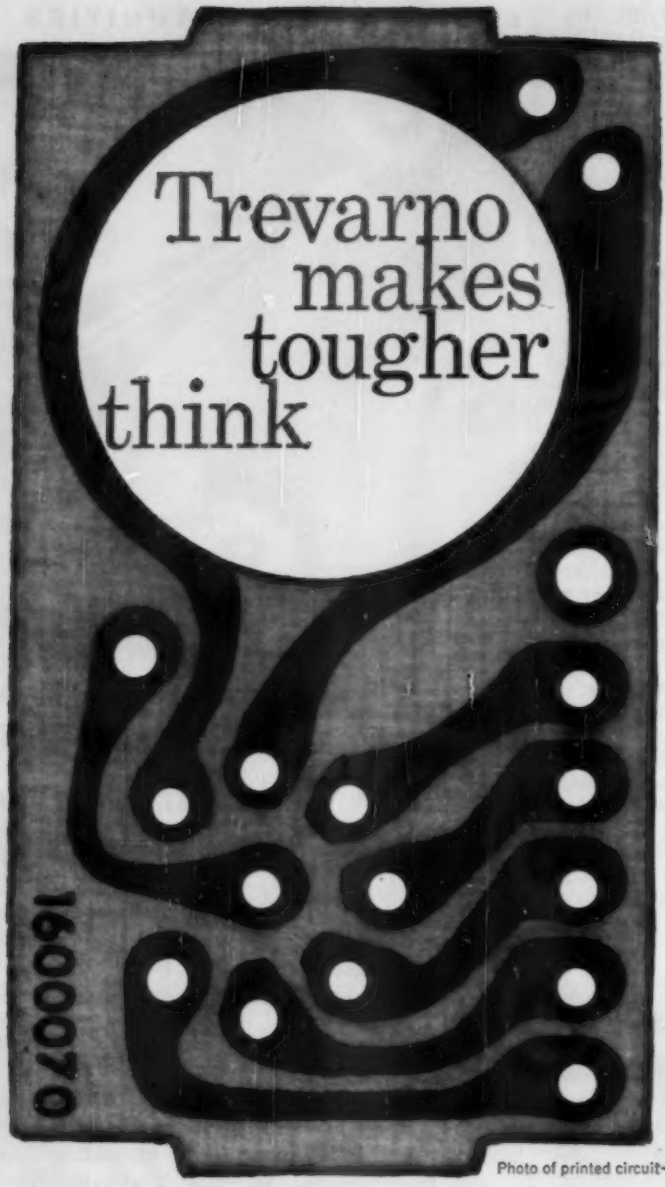
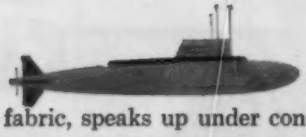


Photo of printed circuit—four times actual size



This sound amplifying circuit, printed on Trevarno resin impregnated glass fabric, speaks up under conditions tougher than you can imagine. It operates at peak efficiency under the most severe conditions of vibration, heat and humidity in Navy submarines. That's why it must have tough insulating backing that won't shrink, swell or bend; resists temperatures of more than 500° F. Laminated of Trevarno epoxy impregnated glass fabric by the Mica Corporation, "Micaply" backs up printed circuitry produced by Etching Company of California for military craft both in the air and under the sea. If you want to make a product better Trevarno's staff of experts is ready to help you develop new or special materials meeting the most exacting specifications. Write Coast Manufacturing & Supply Company, P.O. Box 71, Livermore, California. Sales offices: 4924 Greenville Avenue, Dallas, Texas; 635 South Kenmore Avenue, Los Angeles, California; 114 North Main Street, South Bend, Indiana. Plants at Livermore, California and Seguin, Texas.

Trevarno
GLASS FABRICS

of this airplane available; i.e., the P3 and S4 models. The former is for cruising, the latter for training and limited aerobatics.

Price of the standard model is $9,100; the de luxe version $9,780.

The Kl.107B can look back on a whole line of ancestors in the lightplane category, some of which are still in service in West Germany, England, Scandinavia, Switzerland and Chile.

Klemm made its first entry into the aircraft construction business in 1919 with what the company claims to be the world's first lightplane, the L. 15, a two-seat model powered by a 12.5 hp. engine. It made its first flight in 1922 over a distance of about 75 mi. from Böblingen to Bensheim adB, Germany. The second prototype, the L. 20, powered by a 20 hp. Mercedes engine, made its debut a year later and was a further step in a new branch of aviation, sport flying.

These first two aircraft were followed in quick succession by the types Kl. 25, Kl. 31, Kl. 32 and Kl. 35 of which more than 2,000 were finally in service, particularly as trainers, all over the world. Of these, the Kl. 31 and Kl. 32 were probably the first lightplanes in the world to have cabins in the early 1930s.

Klemm's Böblingen works were practically destroyed during the last war. In 1955, the Bölkow-Klemm partnership was established and the two engineers got to work on some of the blueprints salvaged among the ruins and gradually developed the Kl. 107 lightplane series.

First Oakland PV-2 Delivered

First flight and interior views of new Lockheed PV-2 executive transport conversion, designed by Oakland Airmotive Co. (AW June 2, p. 77) shows extensive modifications made to make luxury business plane out of World War II Navy patrol-bomber. External cleanup was a major factor in providing 280-mph. cruise speed. Plane is designed to take cabin pressurization, if desired. Interior view of Lawrence Warehouse Co.'s plane shows divan, reclining seats, mahogany cabinet. Plane also has a separate conference area. Centaurus has approved gross weight of 33,000 lb., useful load of more than 14,000 lb. Price of unpressurized model is $150,000-$200,000; pressurization will cost about $150,000 additional.

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If your ambitions call for a position that provides such growth potential for you, send a confidential resume of your training and experience for consideration by engineers in the area most suited to your qualifications. For personalized handling, address your inquiry to Box 748A.

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Physical Chemistry
Applications of plastics
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MECHANICAL DIVISION
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General Mills

German Helicopter Has Single Blade

Bonn—One-man helicopter featuring a single main rotor blade having a counterweight balancing the missing blade has been designed by Hans Derschmidt, of Boelkow Entwicklungen, K. G., Stuttgart. New rotary wing aircraft is a development of a non-electronic helicopter trainer which is scheduled for marketing this year.

Powerplant of the helicopter is a two-stroke two-cylinder Heinkel of approximately 18 hp. at 4,000 rpm. Main rotor diameter is 18 ft. developing a maximum thrust of 440 lb. at 455 rpm. Helicopter's length is 14.3 ft.; height approximately 15½ ft.; width 8.5 ft. Empty weight with floats is 880 lb. and gross weight is given as 1,100 lb.

Derschmidt's helicopter simulator trainer recently was demonstrated to officers of the West German Defense Ministry, U. S. military observers and foreign industrial observers.

For Stage 1 training the unit is mounted on a special pivot and the assembly is prevented from turning on its vertical axis to restrict the student to learning pitch and throttle control. Stability in the vertical direction is maintained partially by means of spring force and partially by the thrust of the main rotor, of similar one blade configuration as the operational helicopter designed by Derschmidt.

Vertical movement is limited to 16 in. on upper and lower limits; a second prototype will have 39-in. travel.

After the student has mastered pitch and twist-grip throttle controls and rudder pedals, the trainer is placed on flotation gear and set in the water. He is then instructed on handling helicopter roll and pitch; a projection on the float gear limiting inclination.

PRIVATE LINES

Two-place training glider is being mass-produced in Red China at Shenyang (Mukden) Glider Factory with help of Polish engineers. Gliders will be distributed to gliding clubs throughout Red China.

Gyrodyne Company of America received additional military contracts totaling $400,000 calling for tactical adaptation of the company's XRON-1 one-man Rotorcycle. New contracts are in addition to $1 million in awards received in recent months by Gyrodyne; additional contracts are reported to be in negotiation. Company is expanding personnel and facilities at St. James, N. Y., and establishing subcontractor liaison.

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Autonetics offers a 12-year stockpile of experience in the design, development, and quantity manufacture of flight controls, inertial navigators, armament controls, automated machine controls, computers, landing systems, radar systems, data processing equipment, and electro-mechanical servo systems – plus a complete flight test section, specialized engineering and production facilities.

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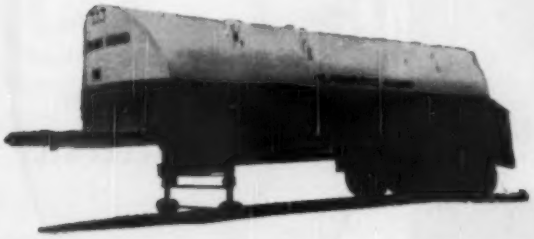
Beechcraft scientists and engineers are at work on numerous projects involving transporting and storing of cryogenic liquids, plus projects in many aeronautical fields. A letter today to our Contract Administration Division will bring full information on how Beechcraft's five major plants, 1¾ million square feet of plant area, and 7,000 skilled craftsmen can help solve your research, development, or production problems.



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COMMUNICATIONS

As our nation grows, the demands made upon communications grow proportionately. Thousands more needs, more jobs.

EDUCATION

The giant school-building program now beginning will offer new jobs to many thousands of construction workers.

TRANSPORTATION

Our growing population demands constantly increasing mobility. Result: thousands of new opportunities, new jobs in the coming Jet Age.

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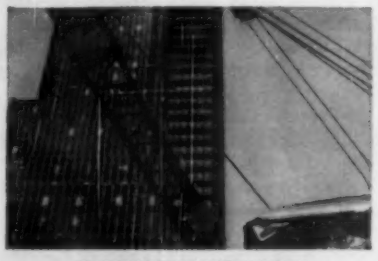
The trend is to labor-saving, ready-to-eat packaged foods. This new phase of an old industry will need thousands more workers.



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3 million workers will benefit from new highway and construction programs—and even more workers will be needed soon.

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4. MORE PRODUCTION—U. S. production *doubles* every 20 years. We will require millions more people to make, sell and distribute our products.

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6. MORE RESEARCH—*$10 billion* spent each year will pay off in more jobs, better living, whole new industries.

7. MORE NEEDS—In the next few years we will need more than *$500 billion* worth of schools, highways, homes, durable equipment. Meeting these needs will create new opportunities for everyone.

* * *

Add them up and you have the makings of another big upswing. Wise planners, builders and buyers will act now to get ready for it.

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Marketing includes sales, consumer research, product and package design, advertising and public relations. All need new skills every year —and *many thousands* of new workers!

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Cruising north along Route 128 through historic Middlesex County, you'll see Sylvania's Waltham Labs high above the highway. Stop off on your way to nearby Lexington for what could be an important interview about a future in advanced electronics with Sylvania.

Big things are happening in your profession at Waltham Laboratories. This is where Sylvania engineers and scientists are developing the Data-Processing nerve-center of BMEWS (giant new program for a Ballistic Missile Early Warning System).

Work on PLATO (AMM system for which Sylvania is Weapons System Manager) is also centered here... plus development programs for other major electronic defense projects.

current opportunities at Sylvania are too good to pass by...

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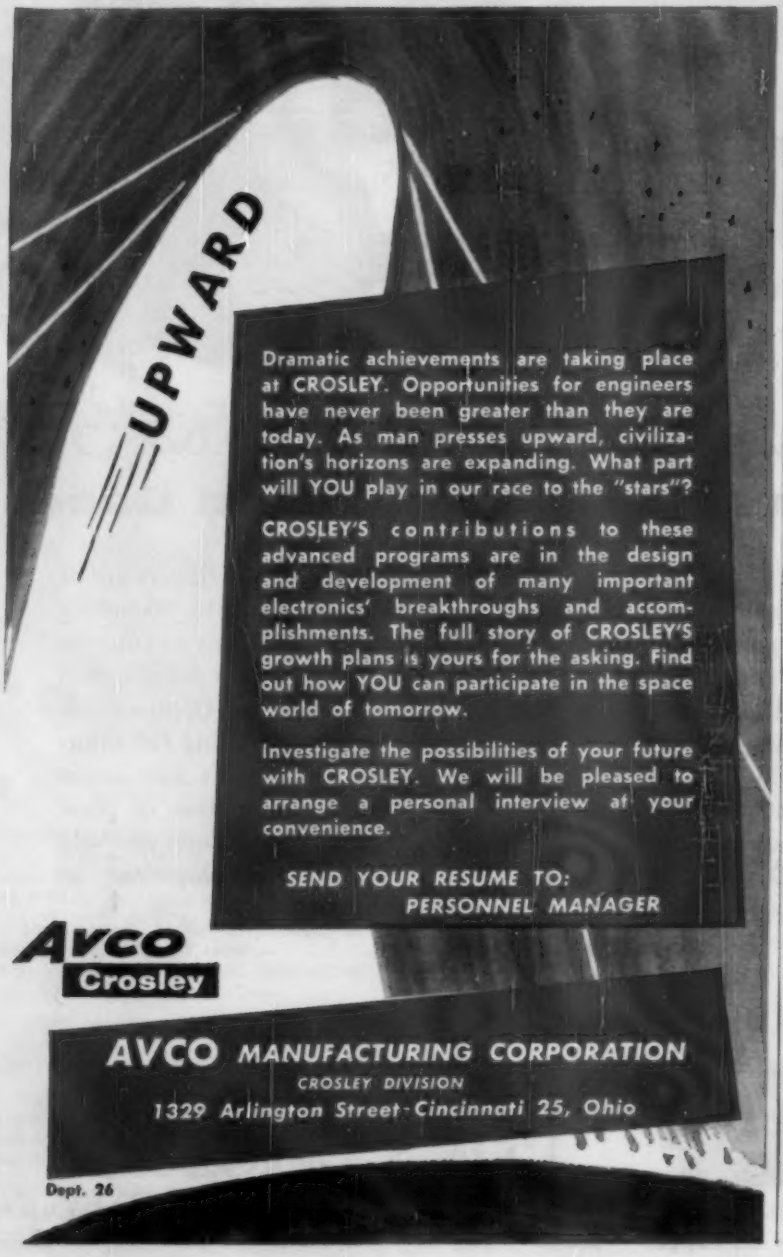
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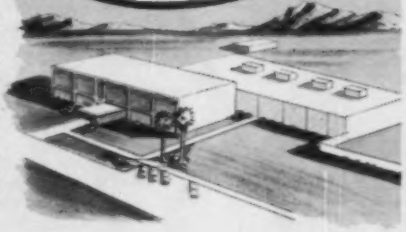

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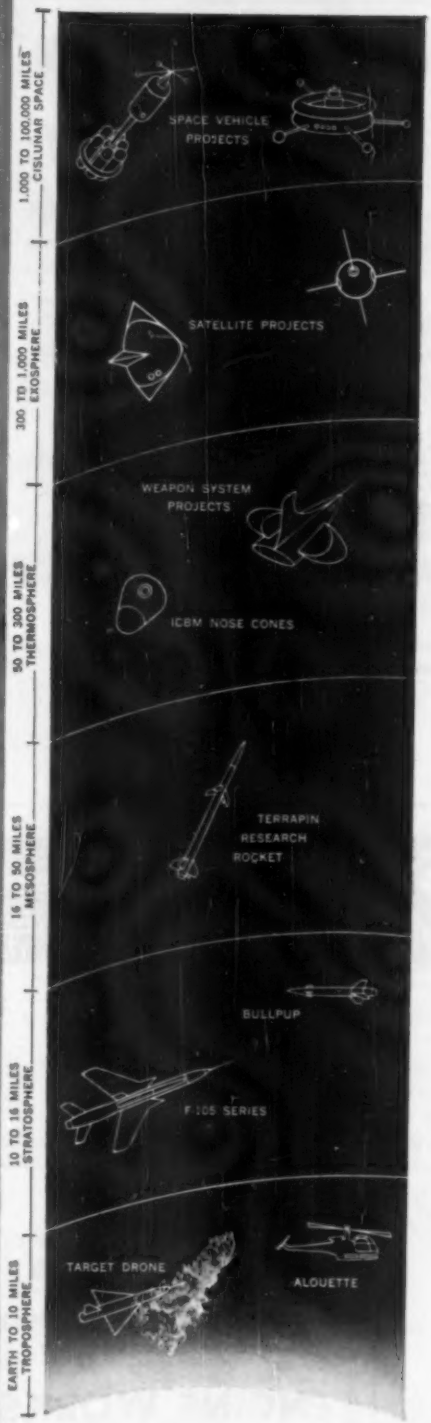

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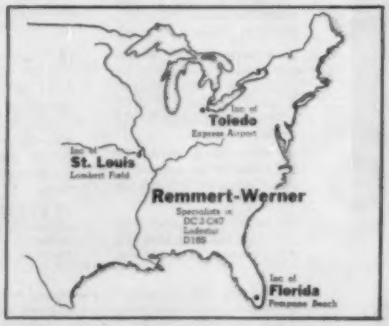

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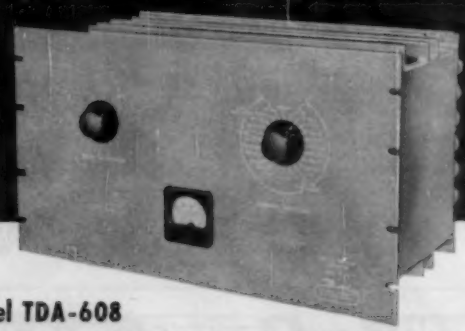

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LETTERS

Neptune's Distance

In the June 16 Research for Space Edition (p. 72-73) you show Neptune 270,000M mi. Its mean distance is actually 30.07 astronomical units corresponding to a mean distance of 2,796M mi. Pluto's mean distance is 3,675M mi.—its aphelion distance 4,589M mi.—its perihelion distance 2,761M mi., which is 49M mi. less than Neptune's at perihelion (due to Pluto's eccentricity which is 0.249). Were it not for Pluto's inclination (17 deg.) their orbits would interlock. As it is they cannot come closer to each other than 240M mi.

Such a mistake is not in keeping with AVIATION WEEK's interesting and accurate reporting.

MAJ. ORVILLE S. RAE (USAF, ret.)
Aurora, Colo.

(Maj. Rae's calculation is correct AVIATION WEEK's artist slipped when he was forced to reletter the original because of overcrowding. The dimension should have been altered to 2,790M mi.—ED.)

Enjoyable Reading

I have just read Michael Yaffee's article entitled "Two Approaches Used in First Production Nose Cones" in AVIATION WEEK, May 12, (p. 52). This article is undoubtedly one of the most authoritative sources of information on this vital aspect of missile engineering. The article is well written, and I found it extremely interesting as well as enjoyable reading.

If reprints or tearsheets are available, we would appreciate copies so that it may be distributed throughout our Structural Plastics Division.

GEORGE EPSTEIN
Structural Plastics Division
Aerojet-General Corp.
Azusa, Calif.

Nose Cones

With reference to Mr. Yaffee's article "Two Approaches Used in First Production Nose Cones" (AW May 12, p. 52), it is interesting to note that mention was made (p. 63) of the "theoretical approach" which ABMA has started to employ. Since Mr. Yaffee has referred to the theoretical work being done at ABMA in his article, it would also appear to be propitious at this time to supplement his remarks with some additional information. To my knowledge, the only approaches which AMBA could be using for the theoretical determination of three-dimensional axially-symmetric stress, and temperature-distributions within missile nose cone structures have been developed at AER, Inc. This work was performed under an unclassified ABMA contract, with Mr. E. A. H. Hellebrand (Chief, Project Staff, Structures and Mechanics Laboratory, ABMA) acting as technical cognizance, and the methods developed thereunder are described in AER, Inc.'s Technical Reports: #111 (30 Aug. 1957), #112 (15 Oct. 1957), and #113 (31 Mar. 1958). However, some further effort must still be devoted towards the development of these methods into "rapid-design" tools. This latter portion of the work is being done by Mr. C. H. Christensen (Computation Lab., AMBA) and should be completed in the near future.

Also, with regards to the cover picture for the same issue, the sled appears to be one which was designed by the Aerojet-General Corp., Azusa, under the direction of Mr. H. Poland. If such is the case, the water brake for this sled was also designed by AER, Inc., where a great deal of unclassified basic theoretical work on rocket-test sled water-braking devices has been done under U. S. NOTS (Code 3083) contracts, with Mr. R. W. Murphy (Head, Vehicle Design Section) acting as technical cognizance.

A. J. A. MORGAN, PH.D.
President
AER, Inc.
Pasadena, Calif.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Neutral Language

May I second the suggestion of Dr. Edmund Bartsch (AW June 2, p. 90) that the international language Esperanto be introduced into regular use among pilots and control facilities in international flying.

My experience as an international pilot extends no further than to the far side of Mexico. Nevertheless, it has been enough to make me wish for some better medium of communication than my lame Spanish and the tower operator's lame English. In Esperanto, on the other hand, I have communicated quite efficiently with Chinese, Brazilians, Poles, etc.

As Dr. Bartsch hints, Russia evidently is organizing a linguistic empire to rival the so-called universal use of English. The far-sighted answer to this would be a proposal to adopt a neutral international language—presumably Esperanto, because of its demonstrated practicality and ease of learning.

PRESTON DAVIS, JR.
Needham, Mass.

Common Language

I was very interested to read the letter you published June 2 (p. 90), written by Edmund Bartsch, about Esperanto. It gave me a chill to think how frightening it would be to be a passenger on a plane setting down in a foreign country and to realize that the pilot and control tower man could not understand each other. What if an emergency occurred? Or what if a passenger required medical attention immediately? At such a time the ability to communicate in a common language like Esperanto would be of value beyond measure.

(MRS.) MARA EDWARDS
Hollywood, Calif.

Purpose of War

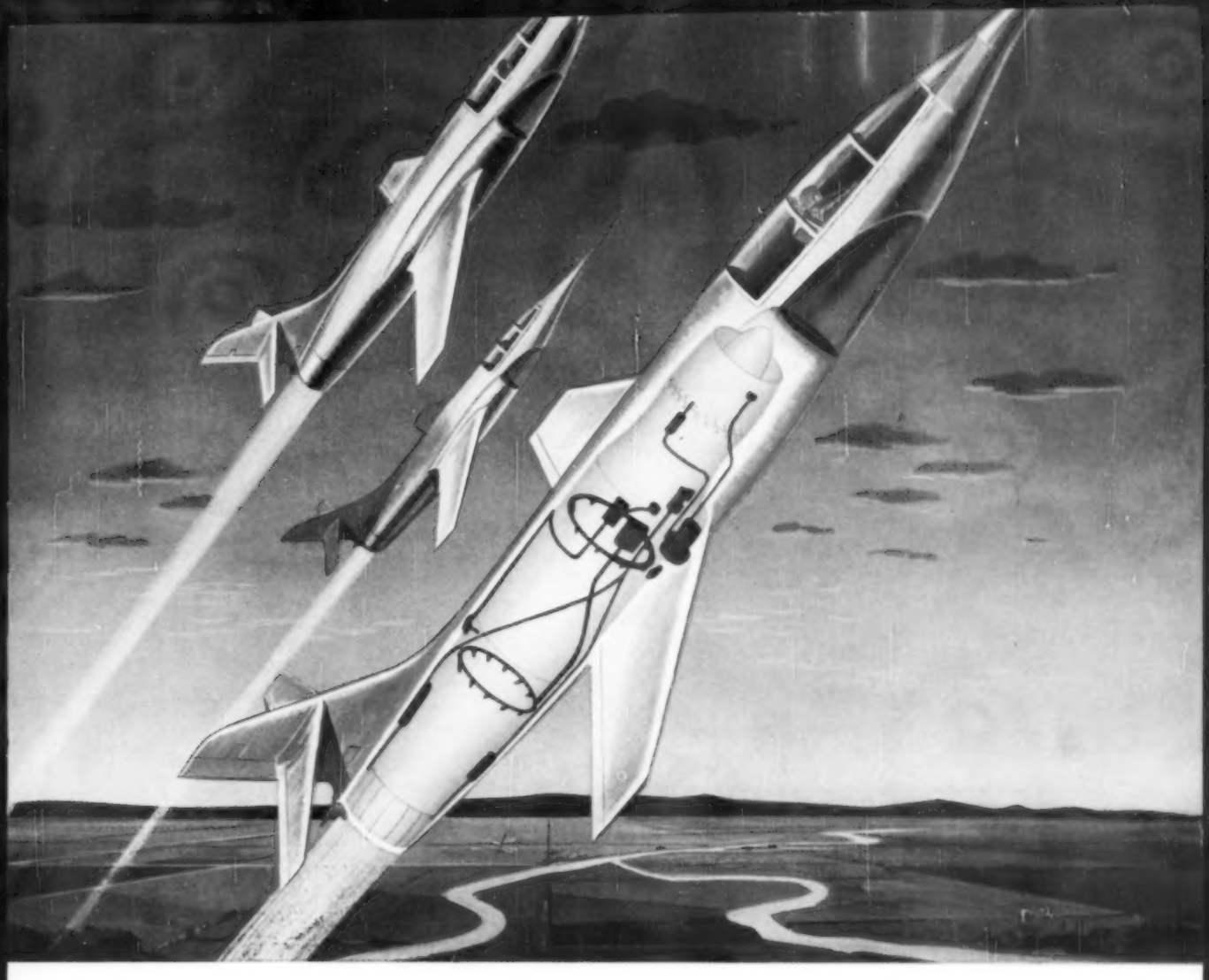
For the past two years the Defense Department has reduced funds for the research and development of a nuclear-powered aircraft. The reason given is that the Defense Dept. doesn't care if the USSR is first to fly a nuclear powered aircraft because the U. S. is concentrating on a complete weapon system with a definite purpose. This weapon system is a supersonic, high altitude nuclear bomber. Its purpose is to deliver nuclear warheads to the target. All other nuclear powered aircraft have been reduced to a lower priority. Apparently the Defense Department has placed primary emphasis on the nuclear bomber in order to assure itself that it will be prepared to destroy the enemy again and again with A and H bombs, if necessary.

The advent of the atomic age in 1945 frightened and surprised the USSR. They responded with great scientific and engineering achievements and a vast program for a submerged Navy. Meanwhile, the USAF continued its program of high altitude bombers like the B-36. This trend continued for 12 years and then the USSR put a dog in outer space. This frightened and surprised the U. S. Navy and finally it, too, began to submerge. The USAF got concerned about the anti-aircraft missiles and future anti-missile missiles. It responded with plans for bombers that will fly almost out of this world. They will be forced to remain there, too, unless they obtain some extremely effective ECM. Even if successful ECM is achieved, the cost of the ECM and the bomber will be very high. It will be too high to use in a conventional war which is the only type we will have to fight as long as we have an adequate stockpile of ballistic missiles.

The B-36 with the A bomb was an adequate deterrent to nuclear aggression during the Korean War. The B-52 with the H bomb is adequate now. In the future the B-58 and the numerous ballistic missiles will be more than adequate. Yet the Defense Department is engaged in a costly duplication of both ballistic missiles and intercontinental H bombers like the B-70. This will enable the U. S. to kill the enemy at least twice which is impossible or imaginary. What is possible and real is that aggressive wars are not fought for the mass annihilation of the human race. They are fought for the conquest of land, the acquisition of economic resources, and the mass enslavement and subjugation of the human race. Defense wars are fought to resist the attempted enslavement and subjugation of the aggressor's way of life.

In an analysis of inter-service rivalry, it is interesting to note that the USAF and the Navy have always received the most funds and publicity, yet during a moment of psychological defeat it was the Army that put the first and most U. S. satellites in orbit. It is also noteworthy that in moments of crises such as "little wars" and big conventional wars, it is always the Army and Marines that do the most fighting and dying.

LEROY F. IVERSON
Manhattan Beach, Calif



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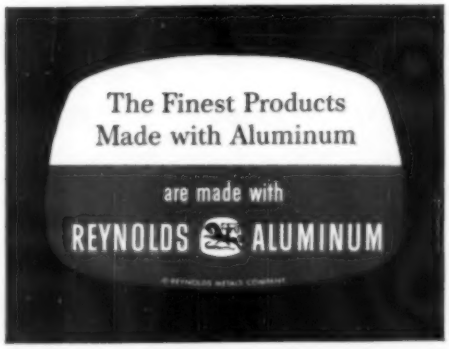

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